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CONTENTS.

ILLUSTRATED ARTICLES: PAGE.
Optical Signaling on Board Ship ... 150
The Sprague Electric Railway System ... 151
Regulation of Dynamos by the Movement of the Commutator ... 157

REVIEWS OF NEW BOOKS:
"Esquisse d'une Théorie Générale des Lampes à Arc Voltaïque" ... 150
"The Age of Electricity" ... 150
"Arc and Glow Lamps" ... 150

CORRESPONDENCE:
Another Complaint Against the Patent Office ... 155
Demagnetizing Watches ... 155
The Financial Side of the Motor Question ... 156

EDITORIAL PARAGRAPHS ... 149

MISCELLANEOUS:
A Portable Electric Lamp ... 150
Voting by Electricity ... 150
Underground Work in New York ... 155
The Government Telephone Suit ... 155
The Canadian Pacific Telegraph System ... 155
Insurance Rules for Incandescents on Arc Circuits ... 155
"Lightning Holes" in the High Alps ... 155
On the Transmission of Power to the Dynamo ... 156
Photometry ... 157
The Oldest Installation in Existence ... 157
No "Cross Talk" on His Line ... 157
The Buffalo Electrical Society ... 157

DEPARTMENTS:
New York Notes ... 157
New England Notes ... 158
Western Notes ... 158
The Telegraph ... 158
The Telephone ... 159
The Electric Light ... 159
Applications of Power ... 159
Miscellaneous Notes ... 159
Personals ... 159
Sparks and Flashes ... 159
Stock Quotations ... 159
Business Notices ... 159
Our Illustrated Record of Electrical Patents ... 160

New Advertisements.

In the growth of THE ELECTRICAL WORLD in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits or interested in electrical matters has not failed to be appreciated by advertisers. Readers will find it to their advantage to keep their eyes on the advertising as well as the reading columns. The following are the new advertisements in this issue:

PAGE.
A. L. Bogart.—Multiple Electric Gas-lighting Apparatus—The Bogart Porcelain Burner ... iii
Harback Organ Co.—Magic Lanterns and Views—The Pocket Type Writer ... vi, xi
E. H. Cadiot.—Agency Wanted for Electrical Specialties ... xi
Kensington Engine Works.—Kensington Purifier and Water Heater ... xvii
Want Advertisements ... xi

Vol. VIII. NEW YORK, SEPT. 25, 1886. No. 13.

BELL telephone stock is quoted below 200, but the earnings are reported to be much larger than usual. Most telephone stocks look like a good purchase just now.

THE great Government telephone suit has begun. At present, however, it is only an affair of outposts. It will be some time, probably, before the struggle begins over the main issues.

REPORT has it that a restoration of telegraph rates by the Western Union and Baltimore & Ohio companies will follow any new arrangement for the use of Jersey tracks. The reasoning from cause to effect is not quite clear, but higher rates may nevertheless be at hand.

IT is a queer state of affairs that finds the average policeman constituted a judge of "necessary repairs" on aërial wires in New York. Are we to have some exemplifications of the familiar story about the knife that underwent so many renewals of handle and blade, but was the same old knife to the end? "Necessary repairs" is a phrase whose meaning will be found to be as elastic as—well, the conscience of the Western Union Company.

CABLE affairs in France do not wear the most brilliant aspect possible. The directors of M. Pouyer-Quertier's company having issued an optimistic circular regarding the reduction in rates, a M. Henry Ternstein comes forward in the name of the stockholders with a counterblast, one passage of which runs thus: "It was said by you in 1880 that the sixpenny rate imperiled our existence. You now pretend to say, in 1886, that this reduction of rate does not mean war, but is merely an experiment." The general meeting will be rather lively, but it would not be safe to predict a reversal of the present heroic policy.

THE interesting fact noticed by Profs. Thomson and Threlfall that nitrogen behaves very much in the same way as oxygen when subjected to the passage of the electric spark is worthy of more extended study. From their experiments it would appear that nitrogen under these conditions undergoes an allotropic change causing a reduction in volume. In the case of oxygen, as is well known, three atoms combine to form one molecule of ozone, whereas the ordinary oxygen molecule contains only two atoms. An analogous combination evidently takes place with nitrogen, reducing its volume as demonstrated.

WE print this week Mr. James A. Pentz's paper read at the late meeting of the National Electric Light Convention, in which he takes a strong stand in favor of the high speed engine for driving dynamos. He analyzes the subject in a very able manner and cites authorities in proof of his statements. There can be no doubt that the high-speed engine is a favorite one among electric lighting men, and deservedly so, but it would be premature to say that the moderate speed engine of good design has been entirely displaced in this field. In fact it will be found on examination that the use of both is to a considerable extent a matter of adaptation to circumstances. Where large powers are employed it will always be a question whether to divide the original source into a number of small units or to concentrate it in one or more large engines. Some stations of a thousand horse-power and over are to-day employing high-speed engines, while on the other hand we all know of others in which the low speed-engine is employed and preferred.

MR. PREECE, one of the pioneers in domestic electric lighting from storage batteries, is evidently bound not to be deprived of his favorite light even upon his travels. As he shows in a short account presented at the recent British Association meeting, he carries a small portable battery with him on such occasions, and astonishes his fellow-passengers by hooking a small incandescent lamp to his waistcoat, which enables him to read in comfort. When he tires of reading, he unscrews his little lamp, inserts a coil of platinum wire and lights his cigarette for a comfortable smoke, without annoying his neighbors with the smell of sulphur. Mr. Preece has already shown what can be done with the electric light in the household, and has now apparently entered upon the task of converting the traveling public to an appreciation of its uses. There is, perhaps, only one class of travelers that would have no use for the electric light, viz., bridal couples on their wedding tours; but they constitute but a very small minority, and are understood to favor matches.

IN the little work of Gladstone and Tribe, the storage battery is treated with more or less fullness from a chemical standpoint, as the actions involved are truly chemical in a large degree. But it is also manifest that many of the difficulties which have been experienced with storage batteries so far are of a mechanical nature, due in some cases, it is true, to chemical action, but in others not directly referable to such a cause. The study of these mechanical difficulties has recently been undertaken by Messrs. Drake and Gorham, who, in a paper presented at the late British Association meeting, describe some very interesting experiments made with the E. P. S. accumulators. The three main points investigated were (1) the cause of the destruction of the lead grid or conductor; (2) the buckling or warping of the plates; and (3) the falling out of the active material. These three important factors in the life of the battery were studied, and some decidedly novel results were obtained. One is that the integrity of the lead grid and the freedom from buckling are in no way dependent on the amount of charging or discharging of the cell. In order to preserve the lead plate the experimenters found that it was necessary to charge the cells fully on the occasion of their first use, and that they should never under any circumstance be entirely run out. The buckling of the plates, it would appear, can also be prevented by charging incessantly when new until they are considerably overcharged. This, of course, entails a loss of energy, but its amount is small, and the gain shown in the working of the battery fully compensates for it. The cohesiveness of the peroxide, finally, it is shown can be secured by a certain proportion of sulphate, which, however, must not be exceeded. Other results of importance connected with the above have also been obtained, which combined give promise that the difficulties under which the storage battery has been laboring are decidedly on the wane. All the results recently accomplished confirm this, and great credit is due to Messrs. Drake and Gorham for calling public attention to such vital improvements in the handling of storage batteries.

THE coinage of new words in electrical nomenclature continues. Among the latest additions are "monophotal" and "polyphotal," which apply respectively to arc lamps designed to be run singly or in series. This distinction is made by Dr. Julius Maier, whose new work on "Arc and Glow Lamps" is reviewed in another column. It might be thought that such a distinction would be unnecessary at this stage of progress in electric lighting, but when it appears, as shown elsewhere, that in the "oldest installation in existence," seventeen "Serrin regulators" are still employed, each fed by a separate machine, we admit there may be some excuse in addition to that of mere convenience for making such a classification. This venerable installation presents a curious example of the tenacity with which old machinery is kept in operation long after the more improved has come into general use. It would probably have entailed some loss at first to discard the small number of lamps and machines originally installed; and hence, by successive additions which became necessary, the old machines and lamps to the number of seventeen have been put in operation. It may some day occur to the management that they are paying dearer for their light under these conditions than if they ran a single dynamo with seventeen modern arc lamps in series.

THE equipment of the elevated railways of this city with electricity as a motive power has for some time attracted general attention, as the results to be obtained would be of commanding importance, not only for this city, but for other places looking toward New York for the evolution of a rapid intra-urban traffic system which shall entail the least inconvenience to the residents along the lines of the road, and shall be economical at the same time. That the electric railway is eminently adapted to meet the conditions involved has been often pointed out by us, and there only remains the working out of a plan in conformity with each particular case to which such roads are to be applied. One of the most earnest and enthusiastic of those who have attempted to put into practical operation a system which shall relieve the elevated roads of the many inconveniences now attaching to them in this city is Mr. Frank J. Sprague. Our description, on another page, of the work already accomplished by him, and that in anticipation, cannot fail to impress the reader with the magnitude of the problem, and, on the other hand, with the ingenuity and resources at the command of the inventor. The first thing that marks the originality of Mr. Sprague's work is the high potential selected by him—600 volts—the highest which has thus far been employed, we believe, in this class of work. The reason for the selection of this high electromotive force is obvious. Turning to the motors employed, we find them of such a construction that under all conditions the point of brush contact with the commutator remains constant. This is effected by a differential field coil in series with the armature. Recognizing the value of the fact, first pointed out by Siemens, that an electric motor running on a down grade generates current which can be utilized by other motors on the line, Mr. Sprague has made his calculations of the power required for the operation of all the motors on the line. According to his figures, the power so gained makes up for the loss in the conversion and reconversion of mechanical into electric power, and *vice versa*, together with that experienced in the conductors, so that even with the new system no more actual power at the central stations would be required than that developed on the track by the locomotives employed at present. This should set at rest the criticism which has been made that any gain in fuel consumption effected by large condensing engines would be offset by the losses occasioned by the two conversions. The method employed in braking the train, as well as its acceleration, involves the application of a rather novel principle enunciated by Mr. Sprague. Taking into consideration the fact that the work performed by an electric motor is in the ratio of the product of the direct E. M. F. into the difference between the direct and counter E. M. F. it follows that by diminishing within limits the counter E. M. F., the work is increased. And as this can be effected by reducing the strength of the field magnets, we have the apparent paradox, that by decreasing the strength of the field of the motor, its power is increased. Conversely, an increase of the field magnets of a motor under certain conditions diminishes its power. Actual practice bears out theory well in this case, and points to a ready and economical means of regulation.

REVIEWS OF NEW BOOKS.

ESQUISSE D'UNE THEORIE GENERALE DES LAMPES A ARC VOLTAIQUE. By Georges Guéroult. Paris. Gauthier-Villars, 1886. 43 pp., 12 mo.

The author has sought in this little work to point out the true relations between the different parts of the mechanism of an arc lamp, and has discussed their action from a mathematical standpoint. Each type of lamp, including the direct current, shunt and differential, is treated separately, and deductions are made which can be applied in each case. For those interested in arc lamp construction the book contains considerable food for thought.

THE AGE OF ELECTRICITY. From Amber-Soul to Telephone. By Park Benjamin, Ph. D. New York: Charles Scribner's Sons. 1886. Pp. 381. Illustrated. Price, $2.

Few things are more difficult than the popularization of science. In explaining matters esoteric, it is hard to know at what point intelligent comprehension by the public will stop, or how far it is wise and safe to enter into details that are important and essential but may confuse and perplex. Perhaps because the task is one requiring no mean skill, it is often attempted by those who, while they are able to penetrate nature's innermost mysteries, are utterly wanting in the qualifications of a teacher. Sometimes, however, and fortunately, it falls to others whose familiarity with science in all its abstruseness and technicality is accompanied by a fine appreciation of popular educational needs and that sort of sympathy which enables the choice of the right diction in meeting them. Full acquaintance with the subject is vital, but it is not all; simplicity of style and treatment is requisite, but may be used to disadvantage. The beginner, the young student, and the general reader are keenly susceptible to the charm that comes from lightness of touch, happiness of allusion, vivacity of thought, and ease of movement from theme to theme; and the scientific expositions most in demand are certainly characterized by these elements of success.

In the "Age of Electricity," by Dr. Benjamin, we have an admirable combination of fullness of knowledge with graceful rhetoric and skillful exposition. The author follows the fascinating tale of investigation and application through the centuries with an enthusiasm that never becomes dithyrambic, but that never flags, and with a notable desire to give each discoverer his due. Accuracy of historical and scientific perspective is maintained throughout, and the work has a completeness that is surprising in view of its vast range.

Dr. Benjamin has his own opinions on a great many points. He believes that to Joseph Henry the lasting gratitude of the world is due as "the father of the telegraph," rather than to Morse or Wheatstone. He is a supporter of Reis as antedating Bell. He regards the secondary battery at the present time as "simply a subject for further research and invention."

Faults in the book are few. The gravest slip, possibly, is that in which the Drawbaugh telephone suit is spoken of as still in litigation. It was decided adversely to the Eberly Mills inventor long before Dr. Benjamin's preface was written in May, 1886, and considering the late sweeping judgment at New Orleans in favor of Bell as against Reis, it looks as though Reis were also "out of court" in America. From one passage in the chapter on the dynamo-electric machine a wrong inference might be drawn. Dr. Benjamin, comparing chemical with dynamic electricity, contrasts the quietness of the Western Union battery room at "195" with the noise of an electric light station not far away. The fact is that the Western Union Company has for some time past had in operation a dynamo room immediately connected with its battery room, and makes daily use of the currents therefrom. The chemical cell is no longer its sole dependence.

In typography and illustration the work is worthy its publishers. The cover, on which forked lightning plays around the title, is handsome and appropriate.

ARC AND GLOW LAMPS. A Practical Handbook on Electric Lighting. By Julius Maier, Ph. D. New York: D. Van Nostrand. London: Whittaker & Co. 1886. Pp. 375 12mo. Price, $3.00.

Electric lighting has undergone remarkable development and considerable change within the last few years, and much that is valuable in its literature is scattered through periodicals and other publications. Dr. Maier exhibits considerable industry in collecting this information, and has, in addition, given it the stamp of individuality by exercising discretion in his selection and by supplementing it with the teachings of his own experience.

Although the title of the book would make it appear that the lamps themselves were the chief subject treated of, a good half of the book is devoted to the discussion of kindred subjects, so that the qualification of the primary title is a highly appropriate one. Indeed, the running title throughout the book is "Electric Lighting."

The volume is divided into four parts, which treat successively of the "Electric Light," "Arc Lamps," "Glow Lamps," and the "Applications of Electric Lighting." In the first part, the author, after explaining the difference between the arc and incandescent light, enters into the discussion of the laws and phenomena common to them both, such as the generation of heat and light by the electric current, photometric measurements, the arrangement of leads and lamps, the efficiency of dynamos, and their application to electric lighting.

In the part devoted to arc lamps, the preparation of the carbons is described, though lacking fullness from the difficulty of obtaining information from the manufacturers. Arc lamps are divided by the author into two principal groups, for the designation of which two words have been coined, viz.: "Monophotal" and "polyphotal." The author groups under the first heading all lamps in which only one light is fed by a single source, and under the second, those which can be placed in series to any extent. This classification, as the author states, is in itself of no importance, and indeed can hardly be made to hold strictly to the definition given. An interesting part of this section is found in the general remarks on the construction

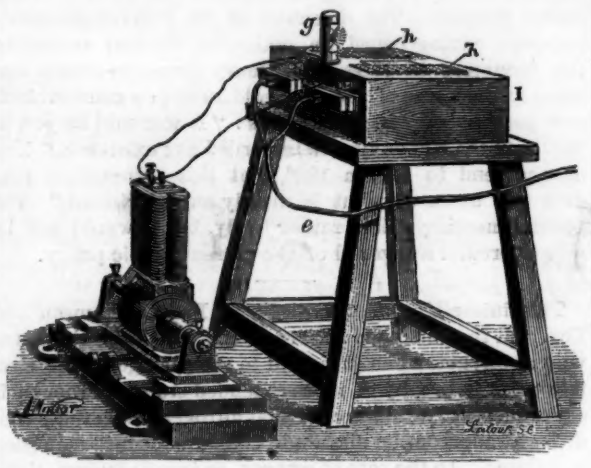


FIG. 1.—OPTICAL SIGNALING ON BOARD SHIP.

of arc lamps, in which the various parts and functions of arc lamps are analyzed in their relation to economy and successful working.

Semi-incandescent lamps, as they are called, are the first subject treated of in the third part of the book under the head of "Glow Lamps," after which the true incandescent lamp proper is taken up and discussed in an able manner. The author seeks to show what are the conditions to be fulfilled in order to obtain an efficient lamp. He therefore enters quite fully into the differences which exist between lamps, consisting in the choice and treatment of raw material of the filament, its length and cross-section, its mode of connection with the platinum wires and the exhaustion of the lamp.

The applications of electric lighting form the subject matter of the remaining portion of the book, in which the various uses to which the light has been and can be applied are described.

Throughout the volume, wherever available, tables have been incorporated in the text. Such competitive tests as those made by the Franklin Institute have due prominence

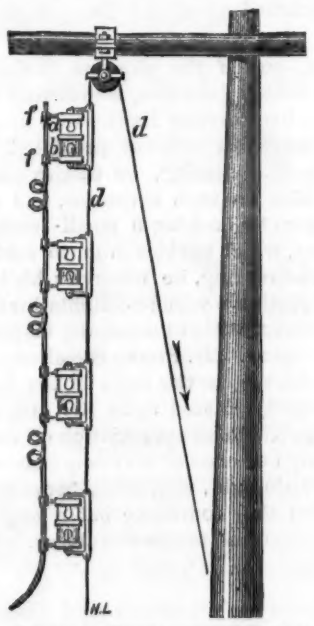


FIG. 2.—OPTICAL SIGNALING ON BOARD SHIP.

given them, though the author evidently does not consider himself bound to accept the results in their entirety.

The statistical portions of the work, or, in other words, the figures given here and there, are, indirectly, striking evidence to the advance of electric lighting, more particularly in this country. Thus Dr. Maier mentions as remarkable for length, a Brush circuit of 12 miles (page 98). There is to-day nothing unusual about that. In Detroit there is an arc circuit 20 miles long, with 15 towers on it, and several circuits could be named longer than that. In another place (page 204) we are informed that the Brush Company has 25,000 arc lamps burning. We believe there are 15,000 Brush lights simply in isolated plants. It is stated that the Edison central stations supply about 33,000 incandescent lamps (page 101). The Edison station capacity at the present time is a little over 120,000 lamps.

The book, as a whole, is a creditable addition to the "Specialist" series, of which it is one of the latest volumes. We note that the author has had the valuable help of Mr. W. H. Preece in the preparation of the work and the revision of proofs.

Optical Signaling on Board Ship.

At the recent Exhibition of Appliances for Inland Navigation, held at Vienna, an interesting combination for optical signaling was shown. It was designed by Ensign Sellner, of the Austrian navy, and consists of three parts, viz.: 1. A small dynamo arranged to be operated by hand, and capable of feeding a number of incandescent lamps. 2. A commutator, or current distributor; both of these are shown in Fig. 1. 3. An optical system consisting of incandescent lamps of different colors.

Four men are required to work the dynamo, which gives a current of 8 ampères at 50 volts. It goes without saying that the generator can also be connected to an engine for continuous work, if desired.

The optical system shown in Fig. 2 consists of four lanterns, each one containing two incandescent lamps *a*, *b*, placed one above the other and separated by a transparent diaphragm. The lamp *a* is a white light, and *b* a red light, and they are sufficiently bright to be seen a distance of from 4 to 8 German miles. (A German mile is equal to about four English miles.) The lamps can be easily removed and the lanterns are hermetically sealed.

These four lanterns constitute eight lights (four white and four red), and are suspended from the yard-arm by a steel cable. They are regularly spaced, the distance between the upper and lower being about 3 metres. In certain cases the lamps might also be placed in a horizontal line.

The cable *e*, Fig. 1, which leads the current to the lamps, is connected to the commutator *I*, Fig. 1, which is provided with a series of keys *h h* and an incandescent lamp *p*.

Each key bears a mark designating a certain combination of lamps, and by merely pressing a single key any combination desired is obtained.

Connected with the apparatus is a register which marks the signals transmitted so that the operator in the hold of the ship can verify his work and also obtain a permanent record of it.

A Portable Electric Lamp.

BY W. H. PREECE, F. R. S.

The demand for a new safety lamp in mines has directed many minds to the application of electricity to this purpose. Some have proposed to use primary batteries; others utilize secondary batteries or accumulators. One of the most portable, compact, and convenient forms is that of Mr. Pitkin. It occupies a cubical space of 59 cubic inches for two cells, and 86½ cubic inches for three cells, weighing 5 pounds 8 ounces and 7 pounds 3 ounces respectively. The three-cell battery gives a light equal to 2.5 candles immediately after removal from the charging source, and lasts for nine or ten hours. I have also used it for other purposes. It is a most convenient portable lamp for going into a wine cellar or visiting our greenhouses, and it makes a very convenient reading lamp for railway traveling. I carry such a battery in my dressing bag, and by means of a flexible cord carrying two copper conductors I suspend by a hook to my waistcoat front a small candle-power Edison-Swan lamp that concentrates upon my book or my paper all the light I want. The lamp is fixed in the focus of a reflector whose surface is enameled dead white, instead of being bright polished. The light is thus much more equably and uniformly distributed. It is, moreover, soft, absolutely steady, and free from smell or annoyance to my fellow passengers. It is lighted instantly without any match, and it can be rapidly replaced by a small coil of fine platinum wire, which, being raised to incandescence, enables me to light my cigarette.

Voting by Electricity.

At the mechanical exhibition at the Palais de l'Industrie in Paris there is exhibited a machine for registering votes which will, it is said, be shortly installed in the Senate and the Chamber of Deputies. Its object is to obviate mistakes, the loss of time, and the necessity of the members leaving their desks to record their votes. The machine, which is the invention of M. Debayeux, is worked by electricity, and the vote of a full house, it is said, may be made known by this means in less than five minutes. The arrangement of the apparatus is as follows:—In front of each seat three contact makers are placed, the knobs being marked respectively "Yes," "No," and "Abstention." Only one of the pushes can be depressed at one time, and neither of them can be used more than once until they have been released by the action of another part of the apparatus, which is under the control of the president. The voting is recorded by means of three sets of cylinders, upon which are inscribed in relief the names of the members in alphabetical order, and also the series of figures from 1 up to the total number of members. These cylinders rotate under inking pads, and after the voting, an impression being taken on a band of paper against the name of each member present, is found a number in one or other of the three columns "Yes," "No," or "Abstention." These numbers appear perpendicularly in numerical order. Hence the total number in each division is read at the foot of the three columns. The apparatus is necessarily somewhat complicated, but it is said to work with great facility. It will be remembered that for some time a similar voting apparatus was exhibited in

one of the Congressional Committee rooms at Washington, but was finally taken away by the inventor, who despaired of its adoption.

The Sprague Electric Railway System.

In December of last year a paper was read before the Society of Arts, Boston, by Mr. F. J. Sprague, on the subject of the application of electricity to the propulsion of motors on the elevated railroads of New York. This paper, which we published at the time, was an elaborate technical article which made a thorough investigation of the power used and its distribution, and indicated some of the methods which the writer proposed to carry out in the system that he had devised. The Third Avenue Elevated Road was taken as an example. It was shown that on this road the work was expended in three different ways, viz.:

1. In overcoming the inertia of the train, which was 59 per cent. of the total.

2. In lifting the train on up grades, which amounted to 24 per cent.

3. In traction, 17 per cent.

It was pointed out that because of the great frequency of stoppages and the necessity of high speeds on this road, most of the energy of the train which was put into it on getting under way and lifting it on up-grades was of little value for traction. At the time this paper was written, there were at commission hours sixty-three trains in operation at one time on the up and down tracks. This was on a double track line of only 8½ miles length. The aggregate power that the engines on this road were capable of exerting was nearly 11,700 horses, the engines being of about 185 h. p. capacity. The average power exerted during the time trains were in motion was 4,640 horses, or, for the entire time on a trip, including stoppages, about 74 horses for each train of four cars.

The problem of how to handle this tremendous power on grades running up as high as 105 feet to the mile, with trains stopping every third of a mile, and sometimes not half a station apart, and sometimes reaching a speed of 20 to 22 miles an hour, is no mean one. It is true that small roads have been operated, among them one six miles long at Portrush, Ireland, but the conditions are totally different, and the demands which would be made upon an electrical system by the conditions of service on the elevated railroads present a new problem, and this problem not alone an electrical but also a mechanical one.

The elevated system presents the result of a great many years of careful thought in engineering study. It is the culmination of a great many improvements. It has been carried to a degree of efficiency far higher than its most earnest supporter thought possible. It has been taxed to its uttermost. Recognizing these difficulties, Mr. Sprague, backed by private enterprise, has been for a long time engaged in the elaboration of a system. Announcement was made some time ago that this system was under trial, and for some time past it has been in experimental operation on the north track of the Thirty-fourth street branch of the Manhattan Railroad. Car No. 293, a full-sized standard passenger car of the elevated railroad, was placed at his disposal by the officers of the Manhattan Company, and this has been equipped and is now a thorough-going experimental car in which a great many problems are being worked out.

The great amount of power which is used on the elevated railroads and the distance over which the trains are handled necessitate in the electric circuit large currents of a high potential. The potential decided on was 600 volts, and the experiments on the Thirty-fourth street section have been carried on with that pressure. No such electrical potential has ever been used in practice for this kind of work. The occasion for it has not existed, and motors which might be used with small powers over short distances and with low potentials would not avail there. Some idea of the current and potential necessary for operating the Third avenue line may be easily gathered from the following facts.

As mentioned above, there are at one time 4,640 h. p. actually being developed. With an efficiency of 80 per cent. for the motors, this would mean a current of 43,291 ampères if one hundred volts were maintained at the terminals of the motors. With 600 volts this would be reduced to 7,215 ampères. The handling of a current of 7,215 ampères and of from 600 to 665 volts electromotive force is a somewhat difficult matter. A conductor to carry this amount of energy without a very large loss under ordinary conditions must be large, but with the stations properly put in and with the rails properly reinforced, together with the methods of working which will be described more in particular below, it will be seen hat the difficulty of handling this has been very largely reduced. We will now enter into a somewhat technical description of this system, both with regard to what is being done and what will probably be done in the future.

The first subject to be considered is the generating station. The system preferred by Mr. Sprague is the operation of a number of dynamos wound so as to generate at their normal speed and with a full load an electromotive force of about 670 volts at their terminals. These dynamos are wound for constant potential circuits. They are of very low armature resistance, and have high-resistance shunt fields. The dynamos may be built so as to maintain a constant potential under all loads at the junction of the mains with the track. There is one disadvantage, however, about this, and that is, if the electromotive force of the dynamos rises automatically, and there should be any very serious cross on the line, the machines might be burned out. Where they are wound with the field magnets in a simple shunt circuit, and no cumulative coil in series with the armature, any very bad cross on a line will lower the potential at the terminals of the machines, and while a very heavy load will come upon them for a brief interval of time, the drop of potential at the terminals will be sufficient to so far demagnetize the field magnets that the machines cannot be burnt out. In addition, however, to the ordinary shunt coil, Mr. Sprague employs a special winding, one which now appears in his railroad motors. This special winding is a coil in series with the armature, whose polarity is exactly at right angles to the polarity set up by the shunt coils, and is so proportioned that it automatically maintains the point of non-sparking coincident with the line of contact with the brushes on the commutators. This series coil would not have the effect of an ordinary cumulative coil. It would not raise the potential of the dynamos, but simply makes them non-sparking with fixed brushes under all loads.

Considering the length of road and the amount of power used it would be better to have two central stations rather than one. These stations would be of the most improved possible mechanical construction. The engines would be compound, condensing, and placed near the water. By this means the coal consumption could be reduced at the central station to as low as two lbs. of coal per indicated horse-power. By having two stations, each removed about a quarter of the distance of the length of the road from either end, the size of conductor which is necessary for the middle rail is only one-fourth that which would be required were there only one station in the middle. Furthermore, the points of supply of current from each station should be maintained at the same differences of potential, to obtain which Mr. Sprague runs an independent line wire from station to station, with suitable indicators in it, showing whenever there is any inequality of potential existing at the supply points. This is done because the highest possible economy requires perfectly equal differences of potential at all points of supply, no matter how many the trains, nor where they may be situated on the track. The combined capacity of the two stations would

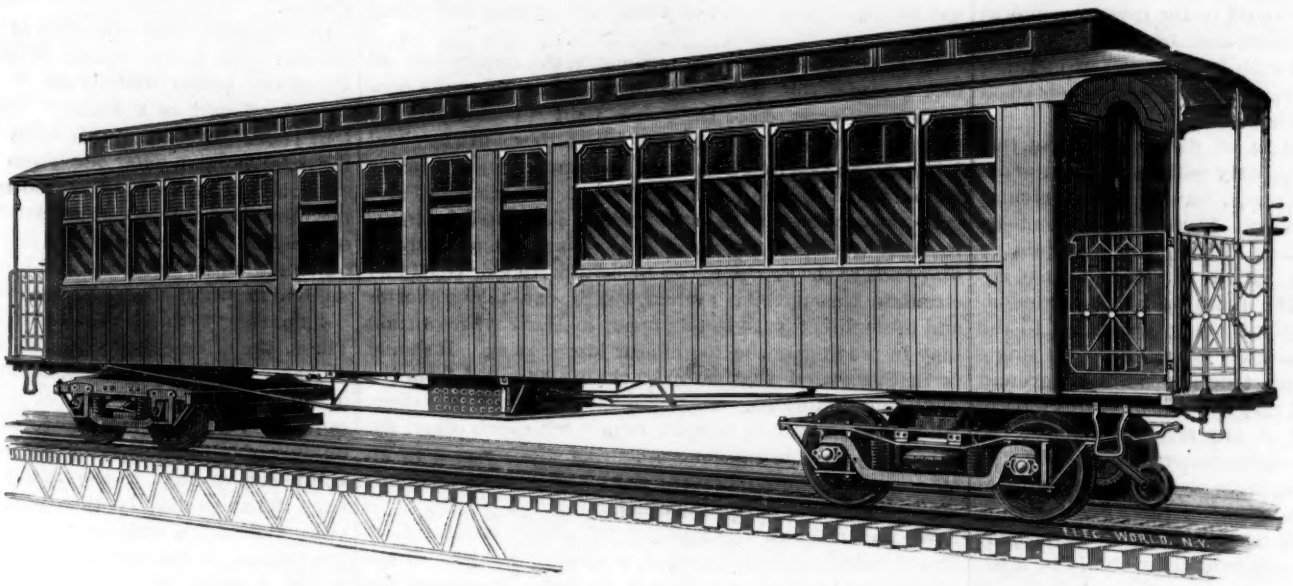


FIG. 1.—SPRAGUE ELECTRIC RAILWAY SYSTEM—ONE-CAR TRAIN.

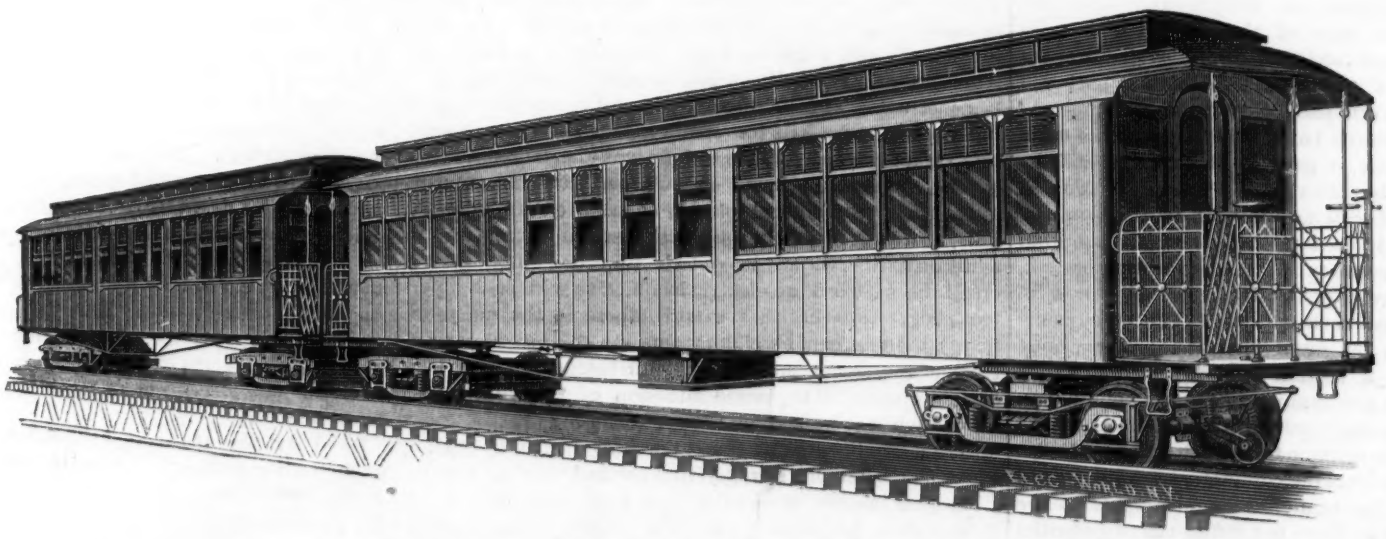


FIG. 2.—SPRAGUE ELECTRIC RAILWAY SYSTEM—TWO-CAR TRAIN.

be something more than equal to the highest total horse-power appearing at any one time on the road, which, as we have seen, is about 4,700 horse-power. It will be noted that there are no losses allowed for here. Why this is so will be explained in describing the system of braking which is used. This, then, would give a capacity at each station of about 2,500 horse-power. On account of the rise and fall of the work done on the line, it being light at night, somewhat heavier during the middle of the day, and at its maximum during the morning and evening, this 2,500 h. p. would be divided up into about four units, and to allow for any break-down of an engine these units would be of about 800 h. p. each. The travel on the road is so perfectly known, and follows such a well-defined law of increase and decrease, that there would be no difficulty whatsoever in starting the engines at the proper time and throwing the dynamos into circuit. This system of power generation would be the most economical possible. With improved boilers and improved methods of burning cheap fuels, and with high grades of engines, compounding and condensing, results would be obtained which would be very gratifying.

We come now to the system of distribution, and this will be described more particularly with regard to the demands of the elevated railroads, leaving out particular reference to street roads, which form a department by themselves. There are many things which pertain to this system of distribution which would, of course, appertain to street work. The main rails are grounded, and form one side of the circuit, being connected to the structure of the road at suitable intervals. Four single rails, together with the superstructure and the ground connections, form a path of very low resistance, and there would probably be no need of any reinforcement at the fish-plates. Should such reinforcement be found to be advisable, a short connecting piece would be made from one rail to another, very much in the same manner as is now done where the track is used for electric signals, or, as with the middle rail, a main conductor would be used. The other part of the circuit consists of a very light rail of special construction, thoroughly well insulated in a simple manner, and raised so that its top is from 3 to 4 inches above the plane of the ordinary traffic rails. This rail is not continuous, being of necessity broken at all switches, turn-outs, sidings and cross-overs. The ends terminate about 18 inches from all crossing traffic rails, and instead of ending abruptly, they are bent down slightly, so that when the collecting wheels, running on the central rail, leave or enter them, they do so without any shock or jar to the spring mechanism which carries them. This middle rail is further divided up into sections of any convenient length desired, say at intervals of 500 or 600 feet.

In addition to this middle rail, there extends along the entire length of the line a heavy, continuous conductor, thoroughly insulated. This is connected to both ends of each section by fusible plugs or cut-outs and a short branch circuit. The branch circuits of the cut-outs form a Y connection, the main conductor being secured to the stem of the Y and one end of each section to the arms of the Y. It will be seen now that in the normal condition of affairs if current is flowing from one part of the road to another part and there is no train between these two parts, that this current is carried over a double ladder-like circuit. The main conductor carries the major part of the current and the sectional working conductors a smaller part. So long as there is no train on the sections adjacent to any connection, it is evident that there is no difference of potential existing at the two opposite ends of the connecting branch, and no current will flow over it, although very powerful currents are flowing past each end of it. These currents will, of course, be in the same direction. When, however, a train enters a section it does not make any contact whatever with the main continuous conductors, but only with the working conductor, and current is supplied to this working conductor from both ends, partially, it may be, through the working conductors next adjacent, but mainly through the branches connecting it to the main conductor; that is, there is a difference of potential set up in the different parts of this circuit, and parts which were inert before become active the moment a train passes on to a section, no matter whether the train be taking current from the line or giving it to it. The current that flows through these branches may be made to actuate any kind of special device which is necessary, and thus forms a perfect block system of signaling, which operates by the presence of a train upon a section, since this train automatically sets signals at both ends of its section. These signals are of a variety of kinds, visual or audible, or both. Some are day and some night signals; and the incandescent lamp, preferably two or more in multiple circuit with each other, are used for the night signals. Since the current on a motor is under perfect control, it follows that even if the train is at rest on the section, the engineer is able to set his signals.

One of the great advantages of this system of main and working conductors is this: If there is any bad cross or accident on the line the section will be cut out. The rest of the road will not be interfered with in the slightest, but the whole circuit will remain intact with the exception of the one particular branch of 500 or 600 feet, which has been affected. The signals may be made of that automatic character such that when a cross does occur sufficient to break the safety catches of that particular section a signal is set and cannot be replaced until the section is repaired. We have here a perfect safeguard against any extended disabling of the line. Furthermore, if it becomes desirable at any time to operate a signal at only one end of the section the other end of the section can be cut out. If repairs are made, a section of the road being taken out or replaced, the track foreman can at once cut that particular section out of circuit, and after his repairs are made put it in again without interfering with the main line. In addition to these devices, the main working conductor can be divided up into sections and switches inserted, so that if it be desirable to cut out any extended portion of the track in case of any accident which makes the passage over a section of the track inadvisable, as in case of a fire, that portion can be cut out without the necessity of disconnecting each individual section.

In addition to these arrangements, the conductors of like potentials on different tracks and switches are connected by cross circuits which tend to equalize the potentials on the line, especially where there are any bad joints in the rail, and also when one track is more heavily loaded than the other. Another great advantage of these cross connections is that the current generated by trains running on down grades and stopping, can not only be sent back to the conductor on its own particular track and circulate through the system, but it can take a shorter and more direct path to the opposite track where a train may be moving on the up grade or just starting. It should be further stated that both tracks are supplied from the same source, forming one complete circulating system. All motors are run in parallel circuit with each other, the current in each being independent of the current in all others, and the motors on the one track are in parallel circuit with the motors on the other.

We now come to the question of motor construction. The elevated railroad presents a special problem, as the strength of the superstructure is limited. At present the trains are drawn by locomotives which aggregate about twenty-two and a half tons in weight. Of this weight only fifteen tons is available for traction, this being the weight on the drivers. This weight of twenty-two and a half tons is centred in a very small space. Immediately behind the locomotive is the forward truck of a car with a proportionate weight of nearly nine tons. There is then a total weight of over thirty-one tons in a space of about thirty-six feet, which is less than the distance between two columns. The consequence is that the strains, both tensile and shearing, are very great; but these strains are not the only source of danger. The vibration set up by a moving train, both vertical, due to the weight, and longitudinal, due to the motion of the train, has a shattering effect which is very great. It tends to loosen the bolts and badly strains the whole structure. There is an additional vibration due to the reciprocal strokes of the steam locomotive and its consequent uneveness of pull. If an electric locomotive were applied to handle a train, and it was made of 15 tons weight, it would pull more than a steam locomotive of equal weight, since all of it could be put upon the driving wheels, and there would be no necessity of additional truck wheels. But a fifteen-ton electric locomotive properly constructed and handled would pull even more than a twenty-two and a half ton steam locomotive with fifteen tons on its drivers. If the weight was distributed on four wheels, the wheels being on two perfectly independent axles, there would be absolutely equal pressure on each. This, however, is not the case with a steam locomotive. In addition to this, the strain could be simultaneously brought on all the wheels of an electric locomotive with such a perfect progression that they would adhere to the rail more firmly than an equal weight where the motion is derived from a reciprocal movement. Furthermore, there is a certain amount of increased adhesion of the wheels, just how much it is impossible to say, because it varies under different conditions, and this is probably due to the heating effect of the current passing from the rail into the wheel.

Another method of handling the cars, and this is the most logical, although it may be a somewhat more costly method of working when dealing with old rolling stock, is the placing of the motors underneath the cars on the trucks which carry them. In this way at least one-half of the weight of the car and the passengers, as well as the motors, is available for traction.

If the motors are thus placed under the cars, each can be made an independent unit, or a dozen cars can be operated in a single train by a small regulating truck placed ahead of them.

This is the manner in which a single car is now being operated on the Thirty-fourth street branch of the Third avenue Elevated Railroad in New York City. The accompanying illustrations, Figs. 1, 2 and 3, show the car in one and two unit combination, and in end view, as it appears upon the track. The truck upon which the car is mounted is shown in perspective in Fig. 4, and in detail plan and elevation in Figs. 5 and 6.

As will be seen, the latter represent a standard iron truck such as is in use on all the new cars of the elevated railroad, with, of course, some omissions and changes which were necessary for attaching the motors. The principal omission is that of all ordinary braking apparatus. There are two motors carried on this truck, each in the space between the axle and the centre cross-piece. The field magnets, which are made of the finest selected scrap wrought iron, are built up of four segments, all forming parts of circles. Two of these form the pole-pieces and to these are attached heavy bronze hangers. The latter carry the armature, which is wound on a special modification of the Siemens system, and has at each end forged steel pinions of 3 inches face, and 3.7 inch diameter on the pitch line. There are 13 teeth only. The hangers are extended and embrace the axle, which is turned off to a perfectly smooth surface, leaving a small shoulder at each side. Part of the hangers extending from the magnet pole-pieces embrace one-half of the axle, and the opposite half is embraced by heavy bronze caps, and inside each there are split liners to take up the wear. The armature shaft, as it passes through the hanger, is carried by two curved self-concentrating sleeves.

On the axles, close to the hub of the wheels on each side, are two split gears. These differ in character. One is keyed and bolted directly on to the axle, which is first turned off, and is a fixture. The other is composed of four parts, two being inner webs which are keyed on to the axle; the two outer ones form the geared section and are bolted together and have corresponding webs projecting inwardly, and fit snugly both on the outer edge and on the face of the webs which are keyed to the axle. The outer and inner webs are held together partially by the method in which they are turned up, but principally by bolts passing through them which work in curved slots. These, then, constitute adjustable split gears, and are probably a new thing in mechanics. The gear wheels are of an especially fine grade of cast-iron, and are of the same face as the pinions which mesh into them. The number of teeth in these gears is 66; they are of the involute cut, so that if the motor should be moved to or from the axles slightly, the gears will still run perfectly true, with only a little more or less closeness of meshing. The pinions on the armature shaft are set so that the one is half a tooth in advance of the other. Ordinarily, it would be a very difficult matter to get the splines on both the armature shaft and the axle and in the pinion and gears, so that they would mesh smoothly when running forward and backward, and it was for the purpose of getting rid of this trouble that the adjustable split gear was designed. It is now only necessary to key the two pinions, one fixed gear, and the web of the other gear in position without any regard to their meshing. The motor is then swung into position, the hangers made to engage the axle, the caps are put on, and the motor being moved forward and backward two or three times while the bolts of the adjustable gear are slack, this gear will assume a perfectly correct position. The bolts are now tightened up and there is thus a nest of double pinions and double gears all meshing with absolute precision, no matter whether the motor runs backward or forward. The method of mounting produces a concentric motion, and by this means the driving and the driven axles are maintained absolutely parallel in two planes under all circumstances.

To allow the motor freedom to follow all the movements of the independent axles over frogs and switches, and also for taking part of the weight of the motor off the body of the axles and to throw it on to the boxes, one end of the motor is suspended at its centre by a bolt passing through the cross girders. This bolt is adjustable, and the upper part is held by a very stiff spring in a state of compression, which spring is in turn supported by a wrought-iron saddle. The motor is then, so to speak, weighed or flexibly supported from the body of the truck. There is also a smaller spring to take up any back movement or tendency to lift of the motor. This suspension is directly in the centre of the pole piece, and the field magnets, which are grooved in the form of a circle, are independently detached from the pole pieces, one of them being put on after the motor is in place.

The operation of this mechanical movement or method of mounting motors has exceeded the expectations of its designer. Because of the relation between the teeth in the pinion and the split gear, it is necessary for the armature shaft to make 66 revolutions before the teeth engage in the same way, and each tooth of the pinion must in turn engage every tooth in the gears. It will be seen also, since the motor is suspended at one end by the truck axle and at the other by compression springs operating in both directions, that whenever the axle is in motion there is always a spring touch, so to speak, of the pinions upon the gears. Barring friction, a single pound of pressure exerted in either direction will lift or depress the motor a slight amount. It follows that no matter how sudden a strain, nor how great, it is impossible to strip the gears unless the resultant strain is greater than that of the tensile strength of the iron; because the moment that the motor exerts a pressure upon the gears, at the same instant do the spring supports allow the motor to rise or fall so as to give somewhat, and no matter how sudden the strain is brought upon the gears it is always a progressive one. The result in practice has been that with a weight equivalent to two tons upon each 30-inch wheel these wheels have actually been skidded in continuous rotation upon a dry track and the strain necessary to do this amounts to from 1,500 to 2,000 pounds upon each gear. Strain has also been put upon these gears as suddenly as it is possible to

close a circuit across 600 volts, and without injurious effect.

This method of mounting motors tends to produce an absolutely perfect form of gear, and has practically obviated the noise which was at first anticipated.

Designs for motors of from 200 to 300 horse-power mounted on these same principles will soon be finished, and the motors constructed and put into operation.

We now come to the electrical features of the motor. The armatures shown in the drawing have a special modified form of Siemens winding. The shafts are built up of the finest forged steel, and the body of the armature is built up with alternating layers of tissue paper and very thin iron discs, such as are used in the Edison machine, which reduces the heat loss due to Foucault currents to a minimum. The difficulties first experienced in dealing with currents of such high electromotive force and large volume have now been overcome. The bodies of the armatures are thoroughly japanned and baked, and the utmost precuation is taken in putting on the different coils of wire to insulate them both from the body of the armature and from each other by the use of a material which offers very high resistance to inductive discharges. The commutators are built of the finest copper, and no insulating material is used other than that just mentioned and fine selected mica.

One of the fundamental features of this system of electrical propulsion is to get rid of all adjustments and to reduce it to the simplest possible system of working and at the same time to maintain as high an efficiency as possible of the motors themselves. For this purpose it was necessary, because of the limited space available, to make the motors of light weight and yet capable of developing a very intense magnetic field. The form adopted for these motors has given these qualities. The motors themselves are built entirely of the finest selected scrap iron specially forged. It was necessary further to have a wide range of speed under full potential at the armature terminals, and hence it was necessary, also, to have a wide range in the magnetic intensity of the field magnets.

A motor when acting in this manner is to be considered under three entirely different conditions:

1. When it is at rest, and it is desired to get the greatest possible torque or tractive effort. This tractive effort should be under perfect control and should necessarily be greater than that which the motor could exert for any very long continued time.

2. When exerting a continuous traction under accelerating speed. This is necessary in getting a train under way, and this effort ordinarily extends over the first third or half of its speed.

3. Variation in the speed of the armature after full potential has been reached at its terminals.

The first characteristic is obtained by bringing the field magnets to a very high degree of saturation. Current is then admitted to the armature under perfect control, and the potential at the armature terminals gradually increased, thus increasing the current until the rotary effort is sufficient to start the train from a state of rest. When the motor is in this condition the torque, or rotary effort, is directly proportioned to the strength of the field magnet and to the current flowing through the armature. As soon, however, as the armature starts to rotate a different condition exists. It is now necessary to exert a continuous traction; but the motor, on account of its accelerating speed, is generating an increasing electromotive force of its own which is counter to that of the line, and the difference between this counter electromotive force and the line electromotive force determines the current through the armature. Consequently, it is necessary, while maintaining the field magnet at the same strength, to still further raise the potential at the terminals of the armature by means of which the current is kept at the same strength. It is impossible to maintain a constant tractive effort in any other way under these conditions. The potential will soon equal the initial, and the motor will be doing its maximum work per unit of time. It is now necessary to accelerate the speed of the train, and this is done by weakening the field magnets. This principle of weakening the field magnets to increase the mechanical effect of a motor at all times when not working up to the maximum was brought out by Mr. Sprague some time ago, when he enunciated the following principle:

In a motor with the armature and field magnet independently supplied, the work which the motor will do in a given time, its economy and efficiency are all independent of the strength of the field magnet, provided the translating devices intermediate between the motor and whatever is the recipient of its energy are not limited as to the rate of transmission of the motor speed; and that in all cases where a motor is working on a constant potential circuit and not up to its maximum capacity, in order to increase the mechanical effect either of speed or power or both, or to compensate for any falling off of the potential on a line, it is necessary to weaken the field magnets, instead of strengthening them. The result is that, if running on a level at a certain speed and a grade is met, and

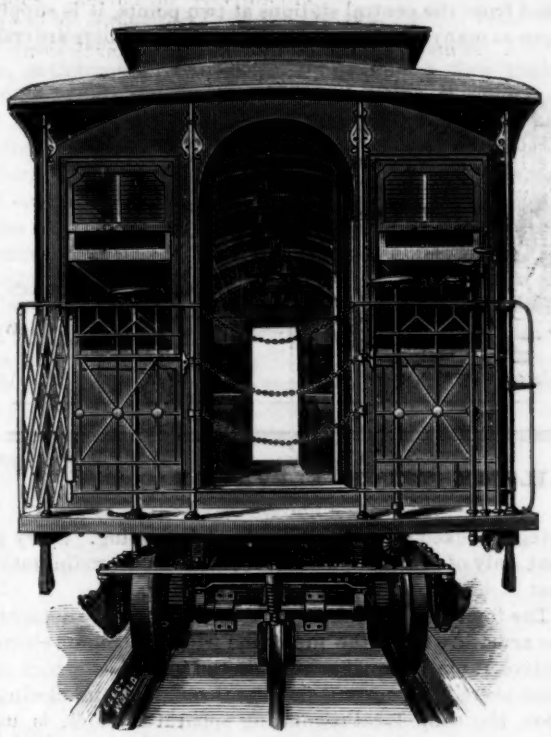


FIG. 3.—END VIEW OF CAR.

it is desired to get up that grade at the same speed, it is necessary to weaken the field magnets. If the potential falls off and it is desired to keep up the same speed, it is necessary to weaken the field magnets, and, conversely, if it is desired to slow down, it is necessary to strengthen the field magnets.

A motor, when running, may be considered as a dynamo driven by a current. It generates an electromotive force dependent upon its resultant strength of field and the speed of the armature, and is independent of all other things. It follows that if the field magnet be under proper control, this counter electromotive force is under perfect control under different speeds, and can be made greater or less in relation to the initial electromotive force, and consequently the motor can be made to do whatever work is desired of it.

This system of handling a motor, which is an essential departure from previous methods, has been carried out to its logical conclusion in braking the train, as will be indicated later.

The winding of the field magnets of the motors is peculiar. One of the great difficulties which has invariably been met with in working with motors is the change of lead necessary to get the brushes at the point of non-sparking. It is absolutely necessary when dealing with large powers, if there is going to be continuous and successful running, to maintain the brushes at such a point. This change of the lead is caused by a distortion which is set up by the armature, varies with every change of load, with every change of the armature current, and with every change in the field magnet strength. It has furthermore been the habit where any considerable power has been developed to use two sets of brushes, one for forward and the other for backward motion. Mr. Sprague has entirely obviated the necessity for doing this by an arrangement which is as simple as it is efficient. This consists in the method of constructing, winding and connecting up the field magnets. The latter are wound with two sets of coils. One of these is a fine shunt coil which is in series with an independent regulating resistance and produces the normal poles; the other is a coarse coil in series with the armature which tends to produce poles at right angles to the normal poles, and this circuit is included in the reversing switch, so that when the armature circuit is reversed the current in the coarse coil is also reversed. There are then four poles set up in this machine, two being normal and variable at will, the other two being abnormal, variable poles dependent upon the current flowing through the armature.

In the normal arrangement of circuits, the two sets of field coils, fine and coarse, combine to set up a resultant polar line which is distorted or rotated in the plane of rotation of the armature. Since any increase in the armature current causes the same increase in the series field coils, the tendency to distortion by these two elements will always vary to the same extent, and the resultant position will be always the same no matter what is the extent of variation of current. If the strength of the field magnet is varied independently of the armature, by changing the resistance in the shunt field circuit or by a variation of potential on the line, while there is a tendency to change the armature distortion, there is an equal and opposite tendency to change the distortion due to the series field coils, and so this, also, has no effect. If the direction of the armature current is changed, so also is that of the current in the series field, and hence the direction of each distortion is changed; but they still oppose each other and vary equally and oppositely as before, and there is still no change in the non-sparking points. It is immaterial whether the change in direction of armature current is due to a change of terminals in changing the direction of rotation of the motor, or is caused in changing the motor into a generator by strengthening the field. Hence, the motor will run in either direction on a circuit of constant or varying potential, with a single or double set of tangential or end-contact brushes, with no change of lead, and, consequently, with no necessity for changing the position of the brushes. The position of the brushes having been once properly adjusted, it is made independent of the amount of work the machine is doing, or the speed at which it runs, or whether it is acting as a dynamo or as a motor. It is likewise independent of the strength of field and of the armature current so long as the magnetic moment of the field sufficiently exceeds that of the armature.

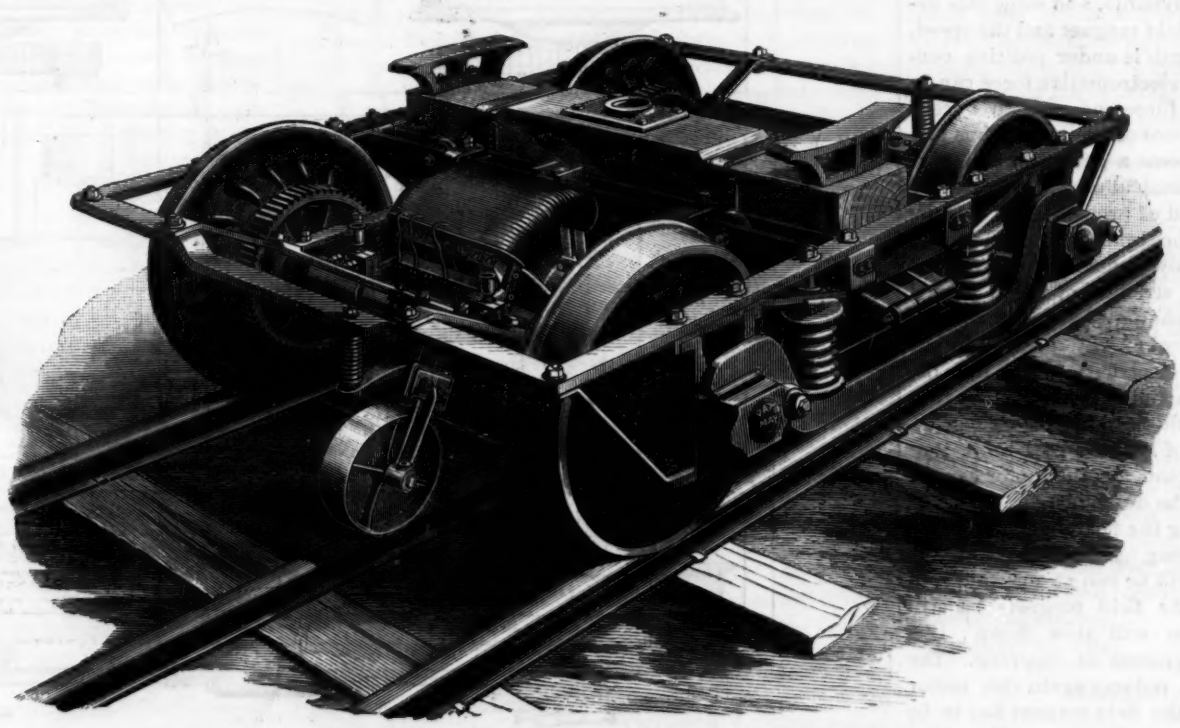
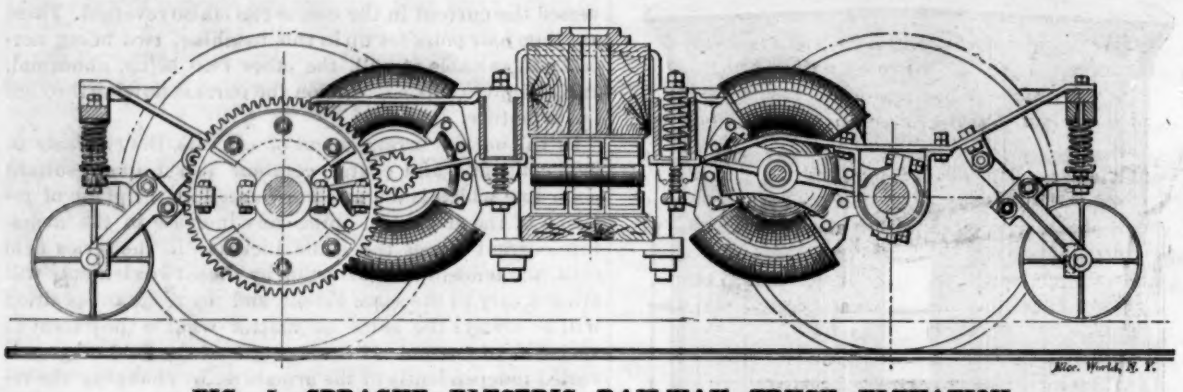


FIG. 4.—TRUCK OF SPRAGUE ELECTRIC RAILWAY CAR.

As will be seen from the end view, Fig. 3, there are at each end of the car three vertical switch rods, each connected by movable links with rods running through from one end of the car to the other. These rods have projecting fingers which operate the levers of three very rapidly-moving switches; the movement of these switches is independent of the rapidity of movement of the hand, which simply stores up energy until a certain point is reached, when the lever is freed and the switch thrown over automatically. These three switches are employed as follows: One for breaking the main circuit; another for reversing the armature circuit; and a third for detaching the armature partially from the line and closing it upon a local regulating apparatus. The movement of the handles on the vertical rods are similar at each end. Forward motion of one means forward movement of the car; forward movement of another means closing the main circuit; and a forward movement of the third means also a throwing off of the brake circuit. So that when a man stands at either end of the car, precisely the same movements mean the same thing as he looks up the track. In addition to these three vertical rods, there is a fourth rod which connects by a beveled gear with a rod running through underneath the car, and provided with universal joints so as to allow of any necessary adjustment. The top of this rod carries a wheel very much like a brake wheel, and it connects with a regulator which consists of a series of resistance coils. These are so arranged that by the continuous movement

of the regulator handle they are first cut out of the armature circuit, while the field is maintained at a high saturation, thereby raising the armature potential, and then cut into the field circuit in reverse manner, thereby weakening the field. This regulator governs also both steps of braking the train.

The current is taken from the centre rail by three conductors, two of which are bronze wheels working on pivoted arms under compression springs. They are provided with adjustable nuts to regulate the tension, and lock nuts to prevent the wheels dropping more than a certain limited amount when leaving the middle rail. The arrangement of contacts is such that the car will span 30 foot spaces without breaking the circuit. The other part of the circuit comes through the wheels of the truck, so



Elec. World, N. Y.

FIG. 5.—SPRAGUE ELECTRIC RAILWAY TRUCK—ELEVATION.

that one part of the apparatus is continually grounded. The collector and the main circuits both run to fusible cut-outs before they reach the main braking circuit, and the armatures are also independently supplied at both ends with similar cut-outs. The armatures and the field magnets are all in parallel circuit with each other.

This is the first instance in which two independent motors have been simultaneously controlled from the same regulating source, and by the methods employed it is perfectly possible to control 20 motors in the same way. When it is considered that the speeds vary from zero to 1,200 revolutions a minute, and the speeds of the two motors should be the same, it will be seen how important a step has been taken. The torque or rotary effort of these motors under slow speeds is very great, and they are able to start from rest and propel two full-sized cars up the maximum grade on the elevated railroad. The motors weigh about 1,200 lbs. each.

We come now to the system of braking, which is the logical sequence of the system of controlling motors originated by Mr. Sprague. As is well known, when a motor is in operation it is generating an electromotive force. In other words, it is acting like a dynamo, and since this depends upon the strength of the field magnet and the speed, and since the field magnet strength is under positive control, it follows that this motor electromotive force can be made to equal the initial motive force and even to exceed it. When this electromotive force of the motor thus predominates, the machine will become a generator and give current to the line, and its mechanical effects are reversed so that it brakes the train instead of propelling it; and the current generated by it, and the braking power, or reversed mechanical effect, are now controllable by further increasing or re-diminishing the strength of the field, and the new dynamo can now be changed back into a motor instantly at will. The mechanical energy received by the reversed motor and delivered as electricity to the line depends upon the mass of the train and its velocity. In running on a down grade there would naturally be an acceleration of speed, but this method of braking can limit that acceleration at any desired point, or the motor can be slowed down when running on the down grade. This is done, of course, by strengthening the field magnets. Since the energy of the train is now being used to run the motors as braking dynamos, the train will be run at a certain constant speed down grade; or if the field magnets be still further strengthened, the train will slow down; this occurs also in the ordinary process of stopping. The diminution of speed, however, reduces again this motor electromotive force, and hence the field magnet has to be strengthened still further as a train slows, until the speed is reached which, with the strongest field magnet, will give a motor electromotive force equal to that of the line. This point with the motors in question is at about one-third speed, or 7 miles an hour. Hence eight-ninths of the energy of a train moving 21 miles an hour is sent back to the line in current to relieve the generating station. In fact, the system as here set out has the advantages of a cable road, together with other advantages which the cable road does not possess; because not only do the trains running on down grades help the trains running on up grades, but those which are slowing down likewise give up their energy to the system. In fact, this system is one in which trains slowing down and running on down grades supply the current for trains running on up grades and starting, and the central station becomes a differential factor to make up for the loss of conversion and reconversion and to provide for traction and loss in the conductors.

Were the machines perfect converters of energy, this would make the power taken by a system almost independent of grades and stops, and would simply be that necessary to provide for continuous traction and for loss on conductors. Of course, this perfection of conversion can never be reached. It does, however, make a difference of 40 per cent. in the power required to operate the electric railroads at the central stations, in the losses on conductors of a given size, and in the investment necessary in the central stations. As a matter of fact, there would be required at the central station only such horse-power as is to-day actually developed at any one moment on the elevated railroads, which is only about two-fifths of the capacity of the motors or engines.

Hence, instead of 7,215 ampères of current being supplied from the central stations at two points, it is supplied from as many additional moving stations as there are trains being checked on a down grade and stopping. Sixty per cent. only of this current would come from the main station; that is, 4,329 ampères, or 2,165 from each.

The final step of braking is done by partially detaching the armature from the main line when its motor electromotive force is equal to that of the initial, at which moment there is no current flowing through it, and closing it upon the same local regulating apparatus which is used for regulating the speed and power, and the first step of braking. By this means the train can be brought to a full stop. All these steps of braking are under the most perfect control, but if necessary the braking can be so sudden as to cause the wheels to have a continuous skidding rotation; not such a skidding as is caused when an air brake is put on too hard, but a rotating slip which will be just enough to relieve the armature when the strain on it has come to a certain point. This is the most perfect possible method of braking, because fixed skidding is an impossibility, and the wheels will turn until the train comes to a dead stop, although where the braking power is put on too suddenly and exceeds the grip of the wheels, they will relieve themselves by slipping just enough to keep the braking at the maximum limit.

With the switch in position for the last step of braking, the car can be allowed to creep down the maximum grades at a snail's pace with a movement so slow as to be almost imperceptible.

It is the customary practice to stop at the Second avenue station of the elevated railroad station, which is on a 95-foot grade, without the use of any shoe-brakes, although the rear truck is fitted with these and can be operated at either end of the car.

By a slight reversal of the armature effort, the car will stand at a dead rest on this grade.

The energy of the train which is expended in the last step of braking can be used in heating the car, and some interesting experiments are now being carried on at the Thirty-fourth street station.

It should be noted that at present the generating station for this experiment is situated on Twenty-fourth street, so that the current at times is carried about three fourths of a mile. The proper electromotive force is obtained by coupling together five Edison machines in series. The wire used is No. 1 B. W. G., and is carried on the Western Union Telegraph poles. Mr. Sprague has by no means rested satisfied in developing his system of railway and carrying it to the advanced condition in which it now is, but he is now engaged in equipping the station and cars along the line of the road with Edison lamps, which are run in series from the same high constant potential circuit that supplies the car, on a system which has been developed by Mr. E. H. Johnson, the president of the company.

A résumé of the special and distinctive features of Mr. Sprague's system may not be uninteresting, and is therefore given below:

A double-track system with motors working in parallel circuit with each other on a constant potential circuit, the two tracks being supplied from the same source and from the same main conductors.

A supply at two or more points by independent batteries of automatically non-sparking machines, the points of supply being maintained at the same differences of potential.

A system of continuous main conductors intersected by switches, and sectional working conductors connected therewith through automatic safety devices.

Means for cutting out, either automatically, in case of accident, or at will, if desired, any portion of the circuit.

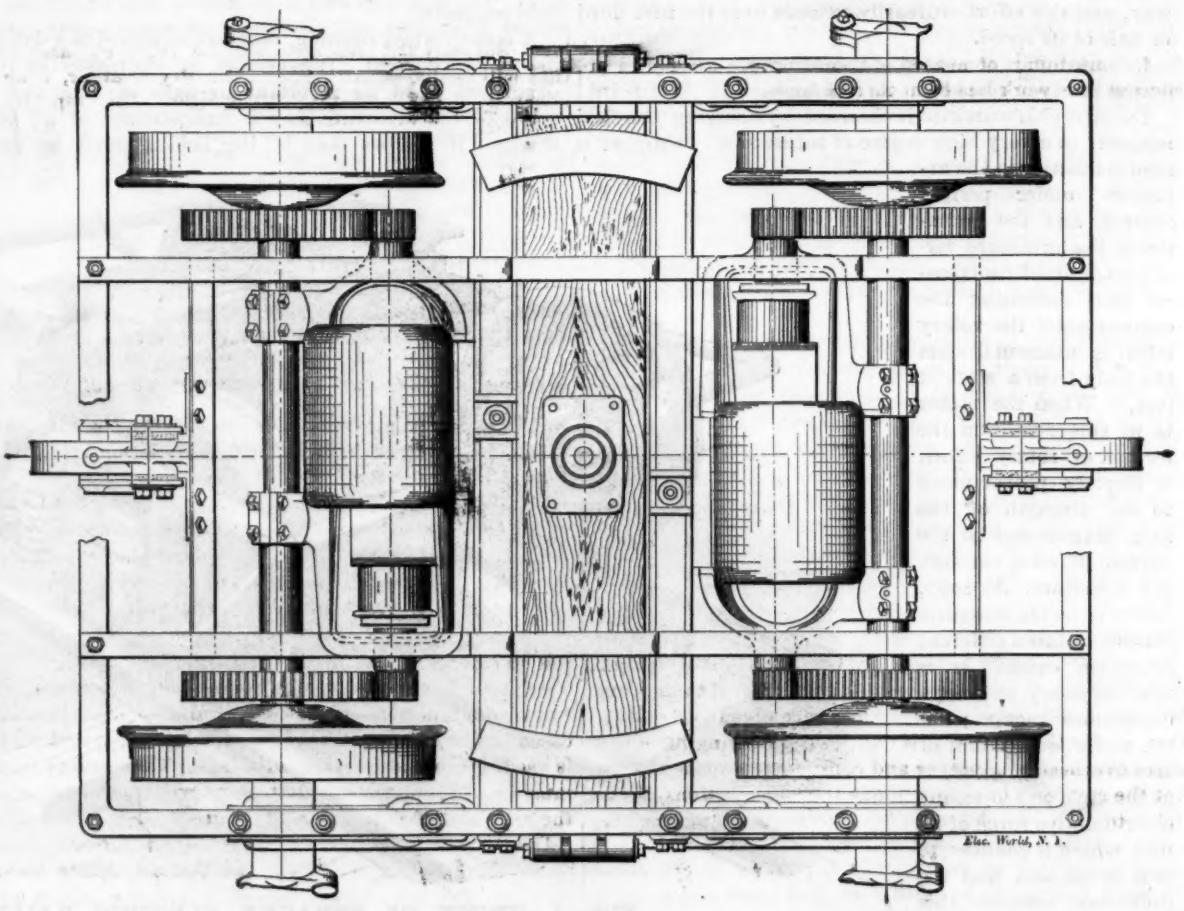
An automatic block signal system for day and night use.

Methods for the equalization of potential by cross connections between conductors of like polarity and on different tracks.

A very simple construction of the motor proper.

The centring of the motor upon the axles so as to maintain parallelism between the driving shaft and the driven axle.

The method of flexibly supporting a part of the weight of the motor from the truck so as to allow perfect freedom in following the motions of the independent axles.



Elec. World, N. Y.

FIG. 6.—TRUCK OF SPRAGUE CAR—PLAN.

The method of doing away with all shock and jar and danger of stripping the gears, and the maintaining at all times of a spring touch so as to prevent any backlash and to insure quiet running.

Double driving from opposite ends of the motor shaft.

The use of fixed and adjustable split gears.

The means for getting a very intense rotary effort in starting by having an intense magnetic field and raising the armature potential gradually.

The means for maintaining a continuous and equal traction until full potential has been reached.

The method of increasing or decreasing the mechanical effects, whether of speed or power, or both, by an inverse varying of the field magnet strength.

The method of controlling two or more independent motors simultaneously from the same source and by the same apparatus.

The use of a single resistance for both the armature and field circuits, each working independently.

The method of winding to maintain the point of least sparking at a fixed position, independent of the load, speed, or power.

The use of single sets of brushes for both forward and backward motion.

A system of braking consisting in converting the energy of the train into current, which is delivered back to the line through the same apparatus which propels the car without any reversal of contacts, whereby a saving of at least 40 per cent. would be effected in the size and capacity of the generating station, in the conductors, and in the coal and labor expended at generating stations.

The final step of braking by means of which the car is brought to rest through the same dynamic action of the motor while the field magnets are still connected with the line.

The method of lighting cars and stations from the main station.

The method of heating cars with a part of the energy of the momentum.

Such is the Sprague system as it is now being actively developed. It is the result of a long and careful course of study and experiment, and is justifying the confidence which has attended its progress.

It has received the most emphatic indorsement of one of the highest scientific authorities in the United States, that of Prof. Henry A. Rowland, of Johns Hopkins University, who closed a long report with the following significant statement:

"Altogether, there is no doubt in my mind that Mr. Sprague's method of working motors for electric railways is thoroughly scientific, and that it has many advantages from a practical point of view. It is also decidedly more economical than any other that has been brought to my notice, and will certainly accomplish what is required in such a case, namely, the moving of a train of cars from one station to another in the least time, with a given maximum speed and with the greatest economy of power and least wear and tear of machinery."

It is a remarkable and unique fact that the Sprague enterprise has been, and is now, a private one.

The development of the railway system has been one branch of the work only, as the company has developed and has in wide use a variety of motors for transmission of power for stationary work.

The energy and confidence which have made Mr. Sprague's success possible are those of Mr. E. H. Johnson, and while the Sprague Company is regularly incorporated under the Manufactures Act of New York, it has not asked the public for one dollar of aid in its enterprise. Confident of success, this work has been carried forward to that point in which there can be no possible question as to its character. A system as important as that just described has, of course, been very thoroughly protected by patents, not alone in the United States, but many have been taken out also in England, France and Germany. Important developments are soon to take place as the result of the success with which this work has been attended, and the elevated railroads are as certain to be operated by electricity as the fact exists that there is such a force. It will not be a sudden change, but a progressive one, gradually adopted only as its reliability and success become apparent. Eventually, probably, there will be a four-track system on a part of the elevated railroads, in which two tracks will be devoted to express purposes, on which single cars will be run at high speeds and with few stops, as this necessity becomes more apparent with every increase in the population of the northern part of New York.

Underground Work in New York.

Latest developments in subway matters show the Western Union Company to be willing and ready for a fight with the Subway Commission as to the burial of their wires. Mr. Lacombe, Corporation Counsel, has given an opinion that, under the laws of 1884 and 1885, the stringing of new wires overhead is improper and constitutes a misdemeanor, but the company have now made their connections, bringing into active employment the cables put along the elevated railroad structure. Dr. Norvin Green said, last week, in regard to the opposition which the Western Union Company are meeting from the Electrical Subway Commission, that the company intend adhering strictly to the franchise which was granted to them May 1, 1883, by the city. This franchise gave them the right to open any of the streets and construct vaults or put in tubes for the purpose of running their wires underground. They did not intend to recognize Mr. Flower, but should apply again to the Public Works Commissioner for permission to open West street to carry their wires from Cortlandt street to Liberty street ferry, and if their application was rejected then they should go to the courts. The stringing of the wires on the elevated roads was more of a public convenience than an inconvenience, as it gave the company easy access to them and enabled them to repair breakage, etc., and thus facilitate business. They had under their franchise laid iron pipes to Twenty-second street in 1883, and they now proposed to run their wires in them. It was absurd to say that the pipes would soon become rotten. Those to Twenty-third street were as good as when first put down.

Orders to arrest men found stringing new wires have been issued to the police, but appear to come rather late. Five linemen arrested in Harlem last week for putting up telegraph cables were at once discharged by the Sergeant on duty, and two telephone linemen brought before a Justice in Yorkville got off on presenting a letter from the Subway Commissioners giving permission to make "necessary repairs."

The Government Telephone Suit.

The hearing of preliminary questions in the suit of the Government to annul the Bell telephone patent was begun on Sept. 20, at Cincinnati, in the United States Court, before Circuit Judge Jackson and District Judges Sage, of Cincinnati, and Welker, of Cleveland. Ex-Senator Thurman, of Columbus; Grosvenor P. Lowery, of New York; ex-Solicitor Goode, of Norfolk, Va., and Jeff. Chandler and Charles S. Whitman, of Washington, appeared for the Government, and J. J. Storrow, of Boston; ex-Senator McDonald, of Indianapolis; Aaron F. Perry, of Cincinnati, and R. A. Harrison, of Columbus, for the Bell Telephone Company. The defendant company has entered a special appearance. The papers thus far filed are the complainant's bill, a motion by the defendant to quash the service of the Marshal, a plea in abatement, and a motion by the complainant to strike from the files defendant's motion to quash the service. It was upon complainant's motion that the hearing was begun. Argument has been made by Judge Thurman for the Government and by Messrs. Harrison and Storrow for the defense, and is still going on at this time of writing.

The Canadian Pacific Telegraph System.

The opening of the Canadian Pacific Railway's telegraph took place Sept. 13, with a through line from Montreal to the Pacific Coast, and with a maze of branch lines, giving connection with all centres of trade and population in Canada. On commencing operations the company will have four direct wires between Montreal and Winnipeg two of which will be used for the movements of trains and other railroad matter. This will leave two wires for commercial business. The wire used in this gigantic circuit is No. 6, and is of a grade particularly designed for long circuits. It was imported from Germany, where it was manufactured under the specifications adopted by the company as a standard. Before the wires of the company were completed right through to Winnipeg, experts expressed the opinion that, despite any precautions which could be taken, it would be impossible to operate this circuit of 1,422 miles without the use of at least four repeaters. But only one repeater will be required, and even that will be dispensed with in clear, dry weather, such as generally prevails during the winter. This repeater is automatic, and the only operators whose hands the messages will pass through will be the sender and taker at either end of the line. The company finds American connections at Richford, Vt., and Morristown, N. Y., with the Postal Telegraph Company. Alliance with this combination gives the Canadian service access to the widely-ramified systems of the United Lines, the American Rapid, Northern Mutual, Postal Telegraph and Bankers & Merchants', besides a number of smaller companies.

Insurance Rules for Incandescents on Arc Circuits.

The following are the rules adopted by the Inspection Department of the Boston Tariff Association for "distributing-box" service:

Only such wire as has been approved by this "Union" shall be used in constructing lines and circuits. Wires must be run in plain sight. In damp places they must have a water-proof covering. The positive wire or wires must be kept at least three inches from the negative wire or wires in running from the distributor or regulator, to the fixtures and lamps, and return, except that "twin wire" may be used for a single lamp. No wires should be run through partitions, floors or walls without being incased in a tube of hard rubber, porcelain, or if soft rubber is used, it must be covered with tape. The "safety fuses" must be so proportioned that they will melt long before the wire is heated to an unsafe degree.

Dust must not be allowed in the distributor-box or any of the electrical connections. The contact points should be kept clean, and care should be taken to insure solid electrical connections at all the points of contact, and all parts must be kept free to move easily. In case any defect should arise in the distributor or regulator, or the wiring thereto, it must be arranged so as to automatically and absolutely shunt off from the arc circuit at once. In working distributors, the line of circuit current must be kept at its standard amount by tests made by ampère-meter, from time to time. In no case must the amount exceed the standard. Every company shall have a competent and reliable person, to examine daily every distributor and regulator, or similar device, which may in the future be applied to arc circuits.

The running of incandescent lights or systems on arc circuits should be avoided; but wherever this is unavoidable, a proper device or "distributor," such as may be approved by this "Union," must be provided to prevent the possibility of an excessive arc current being thrown on to any one portion of the incandescent system; such device or "distributor" must have the approval of this "Union" before it is put in operation. It must remain open to inspection at all times, and no change be made in any part of the installation after it has been approved, without consent of this "Union." Where incandescent lights are run on arc circuits, the following named practices are strictly prohibited: Fastening or attaching electroliers, or lamps, to any gas fixtures which may be in electrical connection with the earth. The running of concealed wires to the electroliers, or lamps, under any circumstances. They must be entirely open to view. The placing of any distributor-box or regulator, electrolier, bracket or lamp in such position that it may be connected in any way with any other wires, steam fittings, gas-pipes, gas fixtures, etc., which may be electrically connected with the earth. The placing of the distributor, electrolier, etc., in any damp location, or in any close proximity to any metal or other conductor of electricity. The building or placing of anything around the distributor or regulator so as to cut off easy access to it, or obstruct the access of air to it.

All joints, after leaving the distributor or regulator, must be soldered, using acid as flux. Resin will not be approved under any circumstances. All new devices should be submitted to the inspector of the "Union," and must be approved by him before permission can be given for their use. Permission is given for the use of the lights and wires of the —— company, located in or upon the within insured premises, when said lights and wires have been introduced in accordance with the rules of the "Boston Fire Underwriters' Union," and having been inspected and approved by the inspector of said "Union."

"Lightning Holes" in the High Alps.

Professor Brun has published in the *Archives de Genève* an interesting study on the so-called "lightning holes" to be found in the High Alps. He and other investigators have found them at heights of from 3,348 to 4,000 metres, or between 11,000 and 13,000 feet above the sea level. Usually they are found on summits. Sometimes the rocky mass, which has been vitrified in the passage of the electric fluid, presents the appearance of small scattered pearls, sometimes of a series of semi-spherical cavities only a few millimetres in diameter. Sometimes there are vitrified rays going out from a central point to a distance of 4 or 5 inches. Sometimes a block detached from the mass appears as if bored through by a cannon ball, the hollow passage being quite vitrified. The thickness of this vitrified coating or stratum never exceeds a millimetre, and is sometimes not more than a quarter of that depth. The varying colors which it presents depend upon the qualities and composition of the rock. The same may be said as to its transparency. On the Rungfischhorn, the glass thus formed by the lightning is black, owing to the quantity of actinolith which the rock contains. It is brown on La Ruinette, the rock consisting of feldspar, mixed with gneiss, containing chloride of iron. Under the microscope, these lightning holes display many interior cavities, which must be attributed to the presence of water in the rock at the moment of melting by the electric discharge. This vitrified material has no influence on polarized light.

Another Complaint Against the Patent Office.

To the Editor of The Electrical World:

SIR: I would call your attention to the wrongful issuing of patent No. 347,768 for a means for storing and utilizing electricity on vehicles (electric railways) to Charles E. Buell, the well-known electrician, as I have pending before the Patent Office an application covering the same invention and with extremely broad and comprehensive claims. It was the duty of the Patent Office to have declared an interference, but having wrongfully issued the patent there is nothing left for me to do but to contest the claim of Mr. Buell by an interference with his patent and settle the matter in court if necessary. The Patent Office has made several of these mistakes lately in the electrical division. I call your attention to this matter, as no doubt the said Buell patent will be brought to your notice as one of importance. R. M. HUNTER.

PHILADELPHIA, PA.

Demagnetizing Watches.

To the Editor of The Electrical World:

SIR: Will you kindly inform me, through the columns of THE ELECTRICAL WORLD, how a watch, which has become magnetized by coming in contact with an electric light dynamo, may be restored to its normal condition? Can it be done by the same agency which has magnetized it?

SKANEATELES FALLS, N. Y. E. F. C.

[There are various methods of demagnetizing watches, more or less complicated. One of the simplest which we have heard suggested is the following: Tie a stout string, as long as can be conveniently handled, to the watch ring, and twist the string so that on releasing the watch the latter will revolve quickly. The twisted string with watch attached being brought close to the magnetic field of the dynamo, release the watch, and as it spins around, gradually withdraw it until it is beyond the effect of the magnetic field. This procedure is said to be efficacious in removing the magnetism from watches, but more refined methods are sometimes required to effect the purpose. —EDS. E. W.]

On the Transmission of Power to the Dynamo.*

BY JAMES A. PENTZ.

To make electric lighting commercially successful, three things are necessary:

Steam must be generated as cheaply as possible.

It must be transmitted economically, and

The apparatus comprising the entire plant for the production of the electric current and its delivery to the circuits must be of the best.

To the consideration of the second proposition this paper is addressed.

First of all, the following statement will be conceded by every one present: We cannot get power through complicated machinery economically. Nor yet is the simplest motor the best one to use when its running expenses are considered.

Plainly stated, if the steam could blow directly upon a wheel without piston or valve gear, as the wind does upon a wind-mill, which we may say is secured upon the dynamo shaft, the problem would be solved, provided the power could be employed in this way as cheaply and as conveniently as is usually done through a more complicated piece of machinery, called a steam engine. But inasmuch as this system has been tried in many ways, and found not to answer, we must look to other methods nearest approaching the cheapest way as concerning the cost of transmission, regarding less, however, the first cost of the motor.

Without going into a discussion on the merits of the different kinds of engines, which would be without end, the statement is perfectly safe to make, that the fixed cylinder engine driving on a revolving crank-pin, is, all things considered, the best. This conclusion has been arrived at after fortunes have been spent upon the steam wheel, the rotary engine, and the oscillating cylinder engine, in futile attempts at making any one of them a successful motor from a commercial point of view, whatever they may have been mechanically.

There are so many things to seek for and inquire about in the subject-matter before us, of such vital importance, that we cannot afford to review it hurriedly. It has not yet received full attention, and as this very important branch of mechanical engineering is not considered as it deserves to be, it may be well to take in some of the points bearing directly upon it, and calmly and without bias look into those factors that have a direct bearing upon its solution.

In treating this question, it is well understood that prejudices will have to be combated and removed, for there are many who, without having looked thoroughly into the subject, are following too closely merely first-tried, unimproved methods, when better ones are to be had for the searching.

The first essential in the employment of power is to get it transferred to the dynamo by means of, and through, the least number of organs of transmission; and it is likewise important to do it mechanically, in the most direct manner.

This brings us face to face with the high-speed engine, and the one-belt method of power transmission from the engine pulley to the pulley of the dynamo as the simplest and the best.

Countershafts as applied to electric lighting are quite unnecessary. They require more space than is usually allotted to the driving plant, adding also to its first cost and to the cost of keeping them in good working order. Any increase in shafting and pulleys must require additional attention, and furthermore, additional power to drive them, thereby lessening the effective force of the engine.

A few tests of shafts are given herewith, to reinforce the general statement just made:

Fifty-five carefully made experiments,† on factory engines, developing under full load from 46 h. p. to 1,485 h. p., showed the percentum of the extremes of resistance of engines and shafting to full load to be from 16.5 per cent. to 39.2 per cent. of the h. p. and an average of 25.9 per cent. of the h. p., while that of the engine alone averaged but 7 per cent.

In another series of eight tests of factory engines, the average proved to be 22 per cent., and in another case, where the total h. p. employed was but 120, the resistance amounted to 33 per cent.

If then, all these drawbacks are to be found in countershafting, it should be dispensed with and some good plan produced whereby electric light plants may be run more economically.

No doubt plants run by low-speed engines driving to a countershaft have given good results, but if we can do better without this useless auxiliary had we not better do so?

It brings us not only to the discussion of the benefits to be derived by belting direct from the engine pulley to the dynamo pulley, but to the superiority of the high-speed engine in connection with electric lighting.

In the employment of this type of engine we gain these points:

I. Economy of fuel and space occupied by the plant.
II. Economy in first cost of the plant.
III. Uniformity of speed and regulation.
IV. Reduction of cost of repairs and maintenance.

Engines of this type must be of the best material and workmanship to insure good running and long life, and should be of ample weight. There should not be the slighest deflection or tremor in the bed under the most trying conditions consequent upon the greatest variation in the load.

The revolving parts must be correctly balanced; the reciprocating parts light and strong; the bearings of proper materials and of ample size; the lubrication automatic, and the parts containing steam should be well clothed to prevent loss by radiation.

The steam in these engines is utilized in the cylinder to much better advantage than in the cylinders of engines running at low speed, and for obvious reasons.

It is a well-known fact, that steam must be used as quickly as possible after it is generated, to avoid loss of efficiency by condensation and radiation of the heat, which is very rapid from the pipes and vessels containing it, as they are usually made and employed.

In the early use of steam in running engines, which were necessarily of slow speed, steam jackets were found absolutely indispensable to the proper action of the engine, but later practice with moderately-speeded engines has shown the warming of steam cylinders by jackets to be unnecessary.

The modern high-speed engine uses the steam as quickly as possible after it is generated, reducing the time of its transmission to the engine to the least, by which the loss of heat is reduced to a minimum. The saving from this source alone is considerable, and as the steam cylinders of high-speed engines are small in proportion to their power, the losses by reduction of cooling surfaces become smaller also.

The economy of fuel as bearing directly upon the engine may be said to begin at this point, and is carried higher by the nearer approach to perfect regulation given by the engine.

The action of the governor of the high-speed engine being quicker, the steam is controlled more easily and the speed of the engine more readily kept uniform.

It has been stated that the friction of the engine is increased when it is run at high speed, but recent experiments made at Cornell University under directions of Prof. Thurston, and with a modern high-speed engine, clearly demonstrated that such is not the case.

M. Morin's Third Law of Friction reads, "That friction is independent of the velocity of motion."* This was announced by him and deduced from his exhaustive experiments made during the year 1834, and this law has been generally accepted by engineers since.

Attention may also be called to the test of a steam engine at the American Institute two years ago. In this test the engine was found to work through a large range of power, with little or absolutely no increase of friction. There were no extraneous conditions that would modify results, and in the machine itself nothing but ample, well-fitted bearing surfaces. According to the generally accepted laws, friction ought to have increased with the load, but numerous careful experiments showed that it did not.

We now come to the most efficient, economical and decidedly the most satisfactory method of dealing with this question, that of belting direct from the driving-pulley of the engines to the dynamo pulley. By this means the connection between the engine and the dynamo is single and direct.

With the best of dynamos, when driven by engines well adapted to the purpose, good belting is necessary to the securing of uniform results.

A case occurred at the Electrical Exhibition, held in Philadelphia two years ago, which will illustrate this point. While the tests were being conducted, a tremor of the lights was observed, which was at once attributed to the engine driving the dynamo.

The fluctuations of the lights were observed to occur in times whose periods were measured by several revolutions of the engine.

The engine was at once thoroughly examined, even to the removal of the governor, which was overhauled and retested by the regular appliances at the shop, but the search revealed nothing that would explain the cause of the disturbance, for the governor was found to be without defect.

The whole trouble was discovered afterwards to be caused by the belt lacing, which, in passing over the dynamo pulley, jerked the belt, and effected the results in lighting.

Belts for driving dynamos should, therefore, be made of the best material, of uniform thickness and density and practically straight in their run through the air and over the pulleys. They should be soft and pliable and kept so by proper application of the usual and obtainable unguents prepared for this purpose.

In the use of belts for driving dynamos, they should be made endless, that is, without laced or other unevenly made joints, and when made of double thickness, care should be taken to select such makes as will give an even and full contact surface of the leather constantly to the faces of the pulleys.

Large-headed copper rivets should be avoided, because they reduce the contact surface of the belts, and coarse stitching and knots should not be used, because they destroy the smoothness of the belt's surfaces. Both diminish the adherence of the belt upon the pulleys.

The best form of engine to drive one or two dynamos, is that in which the steam acts upon a centre crank, with ample shaft bearings on each side, and with the pulleys on overhanging shaft ends.

From each of these pulleys a belt is run to the dynamo pulley. Either belt may be removed by hand when one dynamo only is required to be run.

Where the number of dynamos required is more than two, the simplest method of belting direct to the dynamos is to use two engines, made right and left, set parallel with each other, and with the main shaft connected to, and running in line, with both engine shafts, supported by proper intermediate bearings from the floor. This practically makes it the same as if the engine shafts were extended, and is usually of the same diameter. This being practically inflexible, and running at the same speed as the engine, makes it an easy matter to belt from the pulleys which it supports to the pulleys of the dynamos, thereby delivering the power, with least loss to the electric machinery, direct.

Each pulley on this shaft can be made independent, running by a friction clutch, so that, if by any reason a certain dynamo is not required to be run, it can be stopped, and without interfering with the working of the others.

At either end of the engine shaft, and directly next to the engines, a cut-off friction coupling should be provided. This is to insure against stoppage of the whole plant, if accident should occur to either engine. By this means one engine can continue to do the work.

Without extending these remarks too far, it is proper to add that numerous experiments have proven that better engineering expedients lie within the limits of the larger diameters for shafting, which secures rigidity from the known fact that the flexibility of the smaller shafts usually employed on the score of economy creates more friction by being drawn "out of line" by the pull of the belts in action upon the dynamo.

Again, with regard to the question of perfect regulation of engines. A single engine running at a slow speed will not produce, relatively, as equable a motion as a single engine running at a high speed. To effect regular motion with slow running engines, it is necessary to employ them in pairs, with their cranks set at right angles. Even then the results attained will be no more satisfactory than that effected by a high-speed single engine.

There is a normal speed for every build of engine. It is very certain that an engine made for low speed will not run at a high speed without injury to itself, and possible destruction; but we have abundant testimony proving high speed in engine work to be a pronounced success.

It involves, of course, many of the less-known elements of design and construction, and ever and always the best of materials, workmanship and attendance; all of which, however, are within the reach of modern shop practice, as they are of moderate price.

If proper care be taken in the selection of steam motors after intelligent examination of such as are already in use; if particular attention be given also to the installation and management of the whole plant; and if no part or parcel thereof be accepted, believing it to be the cheapest in the end, because its first cost is least, then will the production of electricity for lighting and other purposes make great and permanent advances.

* Read before the National Electric Light Association, Detroit, Sept. 2, 1886.

† Reported by Mr. John T. Heathorne.

* Page 261, "Fundamental Ideas of Mechanics."

The Financial Side of the Motor Question.

To the Editor of The Electrical World:

SIR: In the paper read by Mr. T. C. Martin on "Motors" at the Detroit Convention, he states that "the intermittent use by the consumer is found to be an important factor in supplying power, as not more than 37 per cent. of that sold is ever called for at one time, so that, allowing for the loss in transmission, at least double the engine service can be sold provided the power is distributed in small quantities. From actual tests made by one company it appears that some few of the averages of power consumed run as low as 14 and 15 per cent." Mr. Martin presents the high authority of Mr. F. J. Sprague to confirm these statements. In other words it amounts to this, that each and every consumer or buyer and user of an electric motor uses but from one-seventh to two-fifths of the power which he pays for. Is this the practice of buyers of otherwise transmitted power? Again, to bring out the above quotation clearer. A company manufactures power for $33 per year per horse-power, and sells this horse-power to a man for $125, and he uses but 37 per cent. of it, consequently it can be resold to the extent of getting $338 for the outlay of $33, and, mark you, I use the higher percentage. What would the profit be if the consumer kindly took but 14 per cent. of what he pays for? The electric light people are struggling along, content with selling power for $175. Is it possible that they have been in the middle of such a flower bed of gullible people and didn't know of it. No reference is made to a horse-power in selling light, but the light is put in without any expense to the consumer and run for so much, while the motor men tell you you can sell your motor, a thing of as questionable value as an arc light, and then charge at the very least for twice what you furnish. My experience is that consumers of power know about what one horse-power will do, and almost universally speaking, they think it will do much more than it will. Sellers of electric power will find by bitter experience that they will have to strike an average price and will not be able to take the whole advantage of the intermittent use. Hence you will be liable to have to carry a load greater than you are paid for, and you will furnish at times less than you are paid for.

To get a remunerative average is much more difficult than with lights. Mr. Martin has one escape in his proviso, *i. e.*, if his "small quantities" are what we jocosely call a "flea-kick" power. Practice will show the above quoted statements to be incorrect, and how they can be given credit by a thinking man is incredible. If you are able to sell the full power of your engine at $125, and sell your motors, you will, after you have made the attempt, rightly feel that you have done well. N.

[If our correspondent will kindly read Mr. Martin's paper again, he will see that he has misquoted it. The *only* citation of Mr. Sprague as an authority is this: "Mr. Sprague tells me that the higher average of from 33 to 37 per cent. will apply not only to small powers, but is absolutely true of large powers, such as 40, 50 or 100 horse, where a number of these are operating from a central station." Mr. Sprague is probably right. As to what capacity can be sold, the *only* expression of opinion on that point by Mr. Martin is the one quoted by "N." himself, namely, that "allowing for the loss in transmission at least double the engine service can be sold, provided the power is distributed in small quantities." Moreover, the remark is applied specifically to Boston. It seems to us that the allowance is well within the mark, certainly one that may "be given credit by a thinking man." At the same time, it is well to have the point raised and to have the whole question ventilated. In regard to the charge made to consumers, it may be pointed out that nowhere in the paper is it suggested that power worth $33 can be resold for $338. "Double the engine service" under the conditions postulated will hardly figure out that way, although retailing electric power in small quantities direct from its manufactory should be very profitable; and it will, we imagine, always be optional with the consumer to decide whether he wants to buy his current by meter rates, or to pay an annual sum for as many horse-power as he knows his establishment requires. In the latter event, instead of proving "gullible," he is as likely as not to overload his motor—if permitted to do so. We know of such cases, and we know also of shrewd, honorable firms that prefer, in taking current, to make a price for their full capacity and pay it, without any meter. It is a great convenience to them to have 5 or 10 horse-power always "on tap."—EDS. E. W.]

Photometry.

Herr Strecker has given a review of the whole question of photometric measurements, and of the various kinds of photometers invented at various times. Since the lights which we have to measure are only perceived by the eye, it is to the eye that we must appeal for the final test of the equality of lights; and it is not desirable to make use of some other effect of light than that produced on the retina, such, for instance, as the action of light on selenium or on some chemical compounds. The eye being the ultimate test, it remains to be seen which is the best instrument to assist the eye in its decision, and this appears undoubtedly to be the form of photometer due to Bunsen, in which a screen of paper with a grease spot in the centre serves to show when the illuminating powers of two sources of light have equal effect on it. In some cases it is preferable to use, in place of the single sheet of paper with the grease spot, three thicknesses of paper, the middle one having a geometric figure of some kind, generally a star, cut out of it. With regard to the standard with which the light is to be compared, the standard candle cannot be recommended, except in the hands of very skilled and competent observers. The normal unit lamp proposed by v. Hefner-Alteneck, in which amyl acetate is burned, can be depended upon with far greater certainty to produce always the same light for the same height of flame; the standard candles, on the average, being about 3 per cent. out. It is desirable, however, when measuring lights of great intensity, to have an intermediate standard, which is first compared with the standard unit, and then in turn used for comparison with the experimental light. For such a purpose, a petroleum lamp of good construction, or a gas flame burning under constant pressure, may be used. A ready method of comparing a batch of glow lamps is the following: In the circuit of a battery are introduced two branch circuits in parallel; the one contains a standard glow lamp of the same type as those to be tested, a resistance, and one coil of a differential galvanometer; the other branch circuit contains the lamp to be tested, a resistance and the second coil of the differential galvanometer. From one terminal of the standard lamp to one terminal of the experimental lamp is a circuit of very high known resistance, containing a galvanometer; this latter serves to show the difference of potential between the two lamps, while the differential galvanometer shows the difference in current, and the photometer the difference in light, and the whole of the measurements can conveniently be taken at once.—*Journal of Telegr aph-Engineers.*

The Oldest Installation in Existence.

It is said that the Paris Hippodrome claims the honor of having been lit by electricity for the longest consecutive period on record. The installation dates back to the year 1877, when four "Serrin regulators" were first permanently installed. Each of these lamps was supplied from a separate Gramme dynamo in the manner then practiced. From time to time the number of arcs has been increased, but, strange to say, the primitive arrangements have not only been retained but positively extended, so that at the present time there are no fewer than *seventeen* "Serrin regulators," each with its separate and distinct Gramme machine! These arcs do not, however, by any means represent the entire installation. There are employed in addition 133 Jablochkoff candles and over 1,000 incandescents. The current for the Jablochkoffs is supplied by seven alternating Grammes, for which four exciters are employed. Three additional direct current Grammes supply a portion of the incandescents, and the remainder are provided for by two Edison machines, each supplying 400 8 c. p. lamps at 110 volts. The total number of dynamos is thus no less than thirty-three. All these machines are driven from one counter-shaft by cotton belting; the counter-shaft is driven in turn by two engines running at 180 revolutions. The machines are mounted on sliding frames, provided with screw adjustment.

No "Cross-Talk" on His Line.

The following is clipped from the Milwaukee *Sentinel* of Sept. 11. It will be remembered that Mr. Hibbard, who has made long-distance telephoning a specialty, has become associated with the American Telephone and Telegraph Company, of this city, working to Philadelphia:

Last evening a party consisting of several of the local managers of the Wisconsin Telephone Company and employés of the Milwaukee office called at the residence of Mr. Charles Ray, where Mr. and Mrs. Hibbard are staying until their departure for New York next Monday. Among those present were the following local managers: Messrs. Stitch, of La Crosse; Gallagher, of Janesville; Stone, of Ripon; May, of Watertown, and Winship, of Racine; besides Messrs. Parker, McLeod, Knight, Lapham, Germain, Hyde, Yopps, Manning, Reilly, Gaulke and Russell, of the city office. That the presence of Mr. Hibbard might be assured, his wife had been notified of the event, but as she guarded the secret faithfully, her husband was taken completely by surprise. When a little maneuvering brought Mr. and Mrs. Hibbard into the same arched window where not many months before they had stood as bride and groom, Mr. George F. Stitch stepped forward and in a very happy speech presented the parting testimonial, a handsome gold watch and chain, bearing on the outside a monogram containing the initials A. S. H., and on the inside the inscription:

WISCONSIN TELEPHONE COMPANY.

A Testimonial from his Telephonic Associates to Supt. A. S. Hibbard. MILWAUKEE, Sept. 10, 1886.

After refreshments had been served Mr. McLeod read extracts from letters of numerous superintendents who were unable to be present, expressing regret that Mr. Hibbard was to leave them, but also pleasure that he had been selected, from the entire country, to fill the new and responsible position to which he had been called. One letter closed as follows: "May his lines of life be clear, unaffected by induction or troubles that may mar or break a perfect circuit, and when the last 'call' is made, may he hear the answer from the grand 'Central': 'Well done!'"

Regulation of Dynamos by the Movement of the Commutator.

One of the earliest and best known methods employed in the regulation of dynamos so that they shall generate the proper strength of current, is that effected by shifting the brushes around the commutator. It is evident, however, that the same result could be obtained by maintaining the brushes in a fixed position and changing the relative position of the commutator.

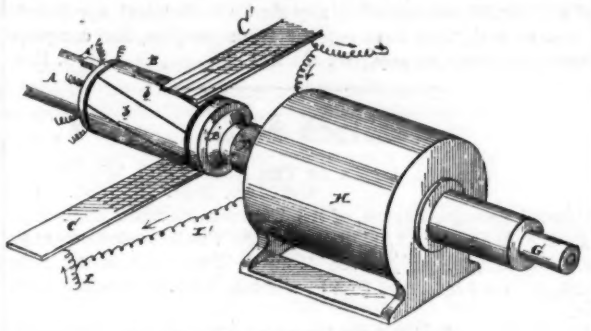


FIG. 1.—MOVABLE COMMUTATOR.

Such a method has recently been devised by Mr. R. M. Hunter, of Philadelphia, and the manner in which it is put in practical operation is shown in the accompanying illustrations, Figs. 1 and 2, which represent respectively exterior and sectional views of the regulator.

As will be seen, the armature shaft *A* is provided with a feather or key *A'*, which fits in a slot in the commutator *B*. The sections of the latter, *b*, are shaped in the form of helices. It is evident, therefore, that if the commutator be moved longitudinally on the shaft, being prevented from rotation by the key, that the brushes will advance a section. The amount of this advance is dependent upon the pitch of the helical sections, which can be made variable.

The commutator has a brass head *B*, which is secured to the soft iron core *D*: the latter enters the solenoid *H*,

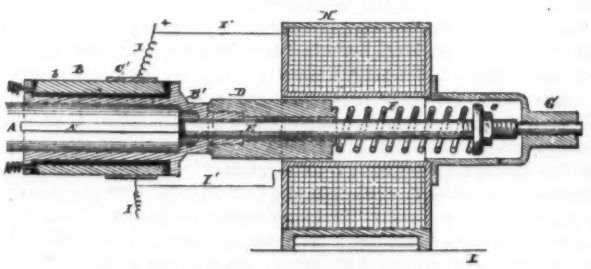


FIG. 2.—MOVABLE COMMUTATOR.

and is guided by the spindle *E*, which is secured to the armature shaft, and has a steady bearing at *G*.

The function of the spring *F* is to oppose the attractive force of the solenoid. The latter is placed in the shunt circuit *I'*; hence, as the resistance in the line increases the current passing through the solenoid increases in a proportional ratio. The core is therefore drawn in further and moves with it the commutator, thus changing the relative position of the segments under the brushes.

It is evident that the same thing can be accomplished by allowing the commutator to remain fixed on the shaft, and moving the brushes not circumferentially, as usual, but in a line parallel with the length of the commutator.

The Buffalo Electrical Society.

President Kitton in his annual address before the Buffalo Electrical Society on Sept. 17, congratulated the members upon the healthy and flourishing condition of their organization as shown by the reports of officers which had just been read. It was gratifying to find that the interest in the proceedings of the society had not been confined to the members alone, but had spread in all directions, and that the local society to-day, in the fourth year of its existence, was stronger than at any other period, and had, it was said, established for itself a national reputation in electrical circles. An election of officers then took place, with the following result: President, William Finn; Vice-President, G. H. Usher: Treasurer, A. C. Terry; Secretary, Samuel Stewart; Librarian, C. C. Smith; Executive Committee, Frank Kitton, H. D. Reynolds, Madison Buell.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
NEW YORK, Sept. 20, 1886.

The Standard Electric Time Company, 252 Broadway, have been engaged for some time past in preparing the mechanism, etc., for the largest clock in the world, one having a face 25 feet in diameter. This clock is to be put against the wall of a building at the corner of Twenty-third street and Fifth avenue, resting on a lower building at the junction of the thoroughfares. The works are composed of sixteen pairs of electro-magnets placed around a six-inch gear wheel. At the face of each pair of magnets is placed an armature extending to the gear wheel. Every second the current from the main line to 252 Broadway brings into circuit 64 cells of local battery, energizing one pair of magnets and starting the wheel, the impulse then affecting each pair in rotation, and distributing the pull or load very evenly. The armatures controlling the movement of the gear wheel are adjusted so that there is no jump when they act, the clock running with a smooth, steady action. There are three gear wheels which turn a long vertical rod; a worm at the top of this rod works on a hollow gear wheel turning the hands of the clock. The dial is painted on the wall of the building, and the hands travel around in front of it as in the ordinary clock. This gigantic clock is intended to serve as an advertisement of sapolio. Messrs. A. & S. Blumenthal and Mr. V. Himmer are entitled to great credit for their enterprise and ingenuity in carrying out the work. The company are now operating a number of clocks throughout the city, all controlled and operated from 252 Broadway.

The various Edison companies, whose growth of late has been so marked and rapid, were, until recently, furnished with the materials of operation by a number of supply and manufacturing concerns, all more or less subordinate to the parent company. Among these concerns, for example, were S. Bergmann & Co., who manufactured all the electroliers, sockets, switches, brackets, etc.; the Edison Machine Works, occupying nearly a block at Goerck street, under the able management of Mr. Batchelor; the Edison Lamp Works, at East Newark, N. J., where 2,000 lamps are made every day from ½ c. p. up to 150 c. p.; the Edison Tube Works, in Brooklyn, where the underground Edison conductors are made. It being deemed desirable to consolidate all these manufacturing establishments, and to unify the direction, the Edison United Manufacturing Company, was formed, as already mentioned in my notes, to take charge of all new business on and after July 1. The company embraces all the various industries I have enumerated, and Mr. J. Hutchinson, who has seen the Edison system safely through many vicissitudes, has been appointed, by unanimous voice, manager of it. The vigorous young organization, or federation as it might be called, is installed in the familiar quarters of the Edison Company at 65 Fifth avenue, and the edifice has been renovated from cellar to roof. It should be known as the Edison Exhibition, and certainly has more ingenuity and intellect to the cubic inch than some displays of international pretensions. The first floor contains a reception room to the right of the entrance, furnished richly and in good taste. Further on, to the left, are exhibited all sizes of dynamos and motors of the Edison and Sprague types. At the far end of the hall is a large room occupied by Mr. Hutchinson and his corps of assistants. If Mr. Hutchinson has the time, he will courteously act as escort, explaining the various devices on view. Any of the fixtures can be illuminated at will, current being available at all times. The second floor is devoted to small fixtures for dining rooms, bedrooms, halls, restaurants, bars, etc., in endless variety and great elegance. The basement contains the boiler, engine and dynamo rooms, and in that part are exhibited model isolated plants for house or marine use, with all complementary appliances in the shape of switch-boards, cut-outs, plugs, wiring fittings, etc. These show Mr. Greenfield's ingenious work. The front room in the basement is the office of Messrs. Noll Brothers, who are doing all the wiring for the Edison Company here.

The completion of the new salesrooms at 65 Fifth avenue furnishes to intending purchasers a convenient place where they can select an outfit for isolated plants of any size or description. The Edison people very naturally look upon the change as marking the opening of a new era in their business. The history of practical incandescent lighting dates back but a few years, but success has already been achieved and the future is secure. The new company comes into the field full of vigor, rich in experience, and equipped for every emergency.

Mr. Jean A. Wetmore, of this city, is experimenting with a new electrical device for use in feeding sheets of paper to printing presses. It has been tested and works well. It is intended to take the place of men or boy feeders. It is quite automatic, and notice of any trouble is signaled by it at once by ringing a bell.

The Vitrite and Luminoid Company is as busy as it can be on its Luminoid lamp, and is now enlarging its factory. Several new departments are to be added. At the offices, 14 Dey street, are to be seen a variety of new safety plugs, switches, fixtures and other appliances noted in Europe by the quick eye of Mr. Mace, and now controlled in this country by his company.

I find general electrical business good, with no complaints except that in some cases the "Old Adam" crops out in a disposition to cut rates. I believe in fair competition at good rates for honest work, and I have yet to meet the man who was permanently benefited by giving or taking an article at a price dishonestly low. Let me give an incident that occurred within my knowledge the other day. Somebody wanted wire, and asked the dealer for a price. It was too high, he said, he could do much better than that with So and So. He got the wire from the dealer, at a price cut 'way down in consequence; but the fact is he never asked the third party for a price at all.

Mr. W. Fix, of 170 Fulton street, one of the oldest reliable manufacturers of messenger call system specialties, has just completed an excellent messenger-box for any number of calls. A leading feature is the return signal; a bell on the box will notify the sender that his call has been received. The box can be set by a subscriber for any desired call or signal, and various other advantages can be gained by its use.

Mr. W. H. Meadowcroft, of the Stout-Meadowcroft Company,

is in England, making investigations and looking up novelties for his New York house. The chances are that he will bring home something worth having.

I had the pleasure last week of meeting Mr. J. D. Haines, of Haines Brothers, formerly well-known as brokers and promoters of electrical stocks. Mr. Haines is now president of several short line railroads in the Eastern and Middle States, and he describes them as very successful. He is now projecting several more roads in New York and Pennsylvania. It may be of interest to some of the motor companies to make his acqaintance.

Mr. C. W. Carter and Mr. Carl Faber, of the United States Electrical Company, in conjunction with two Brooklyn gentlemen, have successfully organized a fire and ambulance call system there. They have arranged to instal offices in every fire-engine house, and are to place a new style call-box, of Mr. C. Carter, Jr.'s, invention, in every house in the city that may be induced, by the low cost of maintenance, to avail itself of the system. Any person on the system will be able to give a fire or ambulance call. The box is simple in construction, and a child can send in the call. The advantages of the system should be investigated by those who see the opportunity to set it up in other cities.

The Phœnix Glass Company, with works at Water Cure, Pa., have a very tasteful exhibit of their products at their offices and salesrooms, 729 Broadway, including electric light globes and shades in opal, flint and "art" glass, for arcs and incandescents. The display of these goods arrests the steps of many a pedestrian, and Mr. A. H. Patterson, the manager, is actively engaged the day through dispatching goods and giving courteous answers to requests for information.

The United States Electrical Company reports an active trade this week. Its motors and batteries are having a brisk sale. The motor will run a heavy sewing machine from two cells of the battery, but the company is frank and wise enough to recommend four to five cells.

The partnership heretofore existing between A. B. Laurence and James W. Herkner, under the firm name of Laurence & Herkner, the well-known belting manufacturers, has been dissolved. Mr. Laurence, I understand, becomes manager for New York and New Jersey for the Underwood Manufacturing Co., manufacturers of "Patent Cotton-Leather Belting," which has established a high reputation in the market. His office will be located at 82 John street, where a full asortment of belting, lacing, etc., will be kept on hand.

Foot-power machinery for workshop use and tools in great variety suitable for electrical work form a prominent department in the hardware business of Chas. E. Little, of 59 Fulton street, this city. Mr. Little is the Eastern agent for W. F. & J. Barnes' patent foot-power machinery, a full line of which is kept in stock at factory prices. The latest addition to the line is Barnes' new screw-cutting lathe, No. 4½. It is back-geared, feeds right or left and cuts screws right or left without any change of gearing. It embodies a number of other attractive features, and experimental electricians or other persons having need of machinery of this kind should get one of the catalogues, furnished on application, containing prices, sizes, etc.

Post's "Zero" metal for journal bearings is a new article recently introduced by E. L. Post & Co., 10 Peck Slip. It is produced by an entirely new process. It is claimed to be shown by several months' trial that the metal will run with from 33 to 50 per cent. less friction than any of the others, or even less than that. It has been run all day at a speed of 810, 65 pounds pressure per square inch—1½ inch shaft 3 inch box—and only increased the heat of bearing and shaft 30° above the temperature of the room. These are noteworthy figures. The well-known Post's waterproof belt oil is manufactured by the same firm. Leather belting dressed with this oil will not crack or rot, it is said, heat, cold, water or gas having no effect on it. The makers also assert that it will spread one-third further and last much longer than the oils ordinarily used for the purpose. It never turns rancid, but will keep in any climate. Belts dressed with it may run at one end in water and in a hot room at the other, and will still be soft, dry and pliable. It is also warranted not to start glue laps or gums on belts or pulleys, and to keep the surface perfectly smooth. With these two specialties, the firm, who are the sole manufacturers, should have no trouble in securing a large electrical clientage.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
BOSTON, Sept. 20, 1886.

The Massachusetts Institute of Technology (Boston) will begin its Autumn term Sept. 27. The class in electricals will be largely attended.

The attractive glass-reflectors on the 34 "Mogul" incandescent lamps in the Boston Music Hall are from the works of the Wheeler Reflector Company.

The Natick Electric Light Company contributed largely toward the success of the illumination which occurred in that town on the evening of September 15.

The Charlestown (Mass.) Gas Company, having entered the electric lighting field and adopted the Brush system, started up its plant of 40 arc lights on the evening of September 16.

The Ben. Franklin Electric Light Company, of Manchester, N. H.—the offspring of the Manchester Gas Light Company—was ready for business on Sept. 18. This enterprise has the arc and incandescent systems of the Thomson-Houston Company. Sufficient orders are in hand for electric lights of both kinds to insure a profitable business from the very start.

The new electric lighting company at Nashua, N. H., held a special meeting on Thursday, Sept. 16, and several more gentlemen were added to the Board of Directors. The name of this new enterprise is the Nashua Electric Light Company. Its handsome plant is completely equipped with Thomson-Houston arc and incandescent dynamos and Armington & Sims engines. Poles are up and wires strung, and everything is in readiness for lighting up.

The Concord, N. H., Electric Light Company is doing a very satisfactory business considering the short period it has been in operation. Sixty arc lights (Thomson-Houston system) are now in use, thirty-five being commercial and the remainder city lights. Orders are in hand for additional arcs from the business men and city authorities, and an incandescent system will soon have to be installed to satisfy the demand.

The rival electric light companies in Waltham, Mass., have both dissolved, with the agreement that the gas company shall put in an electric plant, the stockholders of the retiring companies sharing alike in the stock of the new enterprise. At a meeting on Saturday evening, September 18, a board of directors of nine was elected, of whom five are from the number interested in starting the original electric company. The name decided upon is the Waltham Gas and Electric Lighting Company.

The Cambridge (Mass.) board of aldermen met on the 15th instant and permission was granted the Cambridge Electric Light Company to erect poles and run wires throughout the city. In the same city and on same date the Cambridge railroad stockholders met at Harvard Square and passed a vote favoring the early consideration by the directors of the cable system or any other motive power, other than horse-power, for the Cambridge cars.

Messrs. Sowdon, Elder & Wright (Boston), sole agents in New England for the American system of electric arc lighting, have just had printed an attractive and interesting catalogue. The document has been carefully prepared; contains a recapitulation of the advantages, objects and purposes of the American system—modestly and comprehensively treated—and is neatly illustrated. It has a table on dynamo machines, showing power and speed required, with weight, etc., for machines of from one to 50 lights capacity.

The Ames Manufacturing Company, of Chicopee, Mass., having been engaged for the past forty years in making a general line of machinery for iron and steel workers, recently added another important feature to its business—that of the manufacture of electrical machinery. The company invites correspondence, and will furnish estimates for any kind of electrical apparatus, in iron or steel, from drawings or from samples, for complete dynamo machines, or any part of them.

W. I. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
CHICAGO, Sept. 18, 1886.

General Manager Barton, of the Thomson-Houston Company, is East, as is also Mr. A. K. Stiles, of the Van Depoele Company. Mr. Crossman, formerly of the Thomson-Houston Company, is in Chicago. I am informed that he will take a bride back East with him.

The Van Depoele Company is sending a 30-light arc dynamo to Dennison, Texas. This makes the capacity of the Dennison plant 90 lights. It is also sending a 40-light arc machine to San Francisco, and on Monday it will send a 60-light arc machine to Fort Worth, Texas. The capacity of the Fort Worth plant will be 140 lights when this machine is in place.

Mr. Forée Bain finds his business increasing rapidly; he is just now building to order for one customer three 25-light incandescent and three 25-light arc dynamos. Besides this, he has a large amount of special work in hand, which it will keep him busy for some time to finish up.

I have just learned that a representative of several English tramway companies has been up to Appleton, Wis., examining the Van Depoele electric railway there. He was very much pleased with the working of the road, and is very enthusiastic in his praises of the Van Depoele system. The Van Depoele Company, by the way, have just closed a contract for equipping a line at Port Huron, Mich., and they have also recently furnished the Allegheny County, Pa., Electric Light Company four small motors for power-transmitting purposes. Their motors were specially wound for use with Brush generators, and they work in connection with those generators with entire success.

San Francisco is to have a Western Electric multiple switchboard. The order has just been given.

The Domestic Heating and Illuminating Company, of 82 Jackson street, Chicago, is engaged in furnishing small arc and incandescent outfits.

According to the daily papers, Manager E. H. Brown, of the Western Union Telegraph Company's St. Louis office, is an absconder and defaulter. It is said that Brown has written Superintendent Baker a letter from Windsor, Ontario, acknowledging his shortage, but without explaining how or why he took the money or naming the amount. The examination of Brown's books has not yet been completed, but it is supposed that his bond, which is for $10,000, will cover the shortage. Brown has a wife and five children, and his defalcation is a great surprise.

C. O. Olson & Company are brokers and dealers in lubricating oils for dynamo use, at 31 Milwaukee avenue, Chicago. They are also the sole Western agents for Lord's well-known boiler compound.

We had quite a heavy storm here day before yesterday. Some damage was done by lightning. The electric current seemed to be especially lively at Hermosa, shocking a number of carpenters so severely that some of them will not live.

Goulds & Austin, 167 and 169 Lake street, Chicago, inform me that the Underwood patent cotton leather belting, for which they are the Western agents, is in use in connection with the dynamos of the following companies: Ft. Wayne Jenney Electric Light Company, Ball Electric Light Company, Sperry Electric Light Company, Mather Electric Light Company, Western Edison Light Company, United States Electric Lighting Company, Schuyler Electric Light Company, Bain Electric Light Company, Brush Electric Light Company. This belting would seem to have obtained a very good footing among electric light men.

The telephone situation in Indianapolis remains unchanged. The Central Union people have the field pretty much to themselves. The Wallace Company, outside of stringing one line about a mile in length, have done nothing, and present appearances don't indicate any great activity on their part in the near future. The Central Union Company are still putting in a few new instruments occasionally, and report their business improving somewhat, though slowly.

The toll system appears to be giving fair satisfaction to patrons, with about 700 instruments in use at the present time.

I see that Marion, Ind., has contracted for a Gamewell fire-alarm system.

The two following personal items, taken from the "Club Man's Gossip" column of a local daily, will be read with interest by Western people:

Mr. E. D. Chandler, who used to be superintendent of the fire-alarm service in this city, and is now agent for the largest manufacturers of fire-alarm apparatus in the United States, and Mr. Marvin Hughitt, general manager of the Northwestern railway system, were once telegraph operators in the same office. Mr. Hughitt accepted an offer from the Illinois Central Company, became a train dispatcher, and soon rose from that position to be its general superintendent. After he had begun to rise he urged his old office mates to "catch on" to railroad business. "If you will go at train dispatching," he said, "it is only a question of time when you will get up to something better." Chandler wouldn't do it. He had tried it for a short time, but found the strain on his nerves too much for him. He was in constant terror of running two trains together, and he says his hair would have turned gray years ago if he had kept at it. "Every train dispatcher gets two trains started toward each other on the same track sooner or later," he claims. "He may be able to stop one of them in time to save a wreck and loss of life and property, but sooner or later both will get away from him. I want none of that kind of responsibility."

I saw Prof. Barrett, the present superintendent of the fire-alarm system, standing on La Salle street one afternoon last week, watching a gang of men lowering one of the huge poles on which the web of Western Union telegraph wires was formerly carried. "When I first began to urge the removal of these poles, eight or ten years ago," he said, "everybody laughed at me, and those who thought they knew most told me that I would be under ground a long time before these wires were. Now, there goes about the last of these poles. Pretty nearly all the wires are under ground and are working well, while I'm not buried yet and don't expect to be for a good many years."

I have had quite a number of inquiries lately as to the exact condition of affairs in Montgomery, Alabama, as regards the Van Depoele electric street railway there. In answer to these inquiries I give the following clipping from a Montgomery paper, and would add that the facts as herein set forth have the indorsement of the Van Depoele Company, to whom I submitted the extract:

"Up to this time the electric motors on the lines of the Capital City Street Railways have been experiments. The experiment having proven entirely satisfactory, the test has been declared sufficient, and contracts were yesterday closed for the entire plant. The company here signed the contract several days ago, and it was forwarded to the Van Depoele Company at Chicago. Yesterday, a telegram announced that they had signed it, and the long agony is over. So Montgomery is really to have a 'system' of street railroads operated by electric power, and no mules about it. The motors will be made at once and forwarded. They will be ten horse-power, and will carry a loaded car up hill at six miles an hour. Mr. Gaboury leaves this morning for Philadelphia to buy two new engines of 150 horse-power each. Also iron for three miles of additional track. The work of putting up the poles along the old track and building the new line will begin at once, and be pushed straight ahead. In ninety days it will all be in ship shape. When completed the entire plant will consist of nine miles of track, all operated by electricity; twelve cars and as many motors running; two engines and two batteries of boilers. The saving in the use of electricity over mules is 33⅓ per cent. in operating expenses. During the ten days' final test the receipts were accurately kept, and the electric cars earned 40 per cent. more than the mules, making nine more round trips a day. The buildings of the plant will be on Commerce street and will be of brick, handsomely finished. Work on them will begin next Tuesday. The Hamner Hall line, up Church and Clayton and by Holt to Peacock's tract, will be finished by the time the ninety days are out. The other part of the three-mile extension is a secret as yet. The electric cars will be taken off to-day and kept off until the whole plant is ready. Mules for ninety days and then good bye for good."

Col. S. G. Lynch, stockbroker, 146 LaSalle street, Chicago, quotes Western telephone stock as follows:

Bell of Mo.	$150@$151
Central Union	44@ 46
Chicago	375@ 400
Colorado	20@ 22
Cumberland	70@ 75
Great Southern	25@ 27
Iowa Union	16@ 19
Michigan	67@ 69
Rocky Mountain Bell	40@ 45
United	16@ 18
Wisconsin	104@ 106

W. A. K.

THE TELEGRAPH.

Burlington, Vt., has a new fire alarm in connection with the district messenger service. It is said to work well.

A. D. T. Dividend.—The American District Telegraph Company has declared a quarterly dividend of 1 per cent., payable Oct. 1 to stock of Sept. 20.

Earnings.—The gross earnings of the Central and South American Telegraph Company are understood to be averaging some $7,500 per week. The Mexican company is earning half that sum per week.

"The Main Line" is a new piece by Messrs. H. C. De Mille and Charles Barnard, now playing at the Lyceum Theatre, this city. It is a great hit. The heroine is the little telegraph operator at a mountain station in Colorado, and the play deals largely with railroad telegraphy.

Telotypy.—The Telotype Company, which proposes to establish telegraph communication between various cities in the United States, was incorporated in New York on Sept. 20. The capital is placed at $200,000. The incorporators are Edward J. Mullett, Richard P. Lounsbery, Jenkins Van Schaick, William S. Williams, H. S. Van Duzer.

Fire and Ambulance Alarm.—The Direct Electric Fire and Ambulance Telegraph Company filed articles of incorporation in the Kings County Clerk's office, Brooklyn, on Sept. 18. The incorporators are John W. Carter, Carl Faber and Charles H. Carter, all of whom do business in New York, and Francis Barber and Henry L. Caldwell. The purpose of the company, as stated, is to connect private houses and business places with the fire engine houses. The capital stock is fixed at $300,000, in shares of $25 each.

Death of William F. Drake.—Dr. William F. Drake, General Manager and Superintendent of the Stock Exchange, died on Sept. 19. He was born at Natick, Mass., April 25, 1819, and was educated for the medical profession. He practiced in Boston, London, England, and New York, for twenty years, but in 1861 he abandoned medicine and associated himself with the firm of Drake Brothers, of Wall street, and for many years was interested in many railroads all over the country. Upon the organization of the American District Telegraph Company he became a stockholder and on account of his thorough knowledge and executive ability he was elected its general manager. Later he was persuaded to connect himself with the New York Stock Exchange, and was appointed General Manager and Superintendent. He had a large circle of friends and was always regarded as an energetic and indefatigable worker and able financier. He was a prominent Mason, and had risen through nearly all the grades in the fraternity. Death was due to valvular disease of the heart, from which he had been suffering intensely for seven months.

THE TELEPHONE.

Sandusky, O., telephone exchange, was visited by lightning on Sept. 17, when damage was done to the cupola and switchboard. Some of the young lady operators bravely exerted themselves to put out the fire. About 450 lines were burnt out, suspending service for a time.

Killed by a Wire.—A dispatch of Sept. 16 from Lancaster, Pa., has the following: William Varnau, who was employed by a furniture dealer as driver of his van, died this afternoon from injuries received in a peculiar manner. While taking a load of furniture from the store to the purchaser, a slack telephone wire caught the top of a bedstead. Varnau in releasing it was caught by the wire, which in its recoil threw him into the road a distance of nearly 20 feet. He was picked up unconscious, suffering from a fractured skull, and remained in that condition until death relieved him.

Boston.—In the general offices of the New England Telephone and Telegraph Company, on the corner of Franklin and Pearl streets, there is a veritable curiosity. It is a printed list of 50 subscribers to the telephone. Within 10 years this was in use as the full list of the company's subscribers. These 50 paid $4 per month for communicating with one another; to-day 4,500 subscribers (exclusive of the express department) pay from $6 to $10 per month for communication with the increased number. Ten years has seen the various patents, once embroiled in such legal and other entanglements that some of the most valuable of them were offered for nominal sums, slowly gathering together, till now conversation by telephone takes advantage of 144 of them.—*Transcript.*

Life Saving by Telephone.—The mail from Jamaica has brought details of a narrow escape of a boat's crew of Her Majesty's ship "Urgent," off Port Royal. The boat capsized some distance from shore, and the crew, three in number, being plunged into the water, were in imminent peril of drowning or being eaten by sharks. Fortunately the officers at the signal station observed the accident, and telephoned instant news of it to the harbor. A launch with steam up was lying there, and without a moment's delay this vessel put to sea, and steered at full speed to the rescue of the men. Eight minutes were occupied in reaching the nearest of them. Within three minutes of the arrival on the scene all three men were saved and on board the launch.

The Outlook for Erie.—President Bennett is in the company's Northwestern territory, looking after the business. As to the policy of the company in not increasing the quarterly dividend, a party in position to know says the company is at present earning from $36,000 to $40,000 per quarter above all its expenses and new construction. The present dividend is $24,000, leaving a balance of $12,000 to $16,000. This surplus must be used for the present in reconstructing a large portion of its plant in the Northwestern and Cleveland divisions, and the addition of a new switch-board at Cleveland, which will cost some $20,000. This, with improvements necessary in the Northwest, will amount to some $50,000. The directors have deemed it advisable not to increase the dividend before next year. The question regarding the perpetual contract for the Northwestern division, it is said, will come up about January, 1887, when some temporary licenses for St. Paul and Minneapolis, the American Bell Company claim, expire. On the other hand, the Erie Company has the best advice (Gen. Butler, probably) that their contracts in the Northwest are perpetual. Cleveland contract expires in 1890, Southwestern contract in 1891. The hearing before the arbitrators on salary claims of Ingham, Downs and Bent against the Erie Company will be resumed at Lowell, Oct. 5.

THE ELECTRIC LIGHT.

Ashtabula, O., casts a longing eye on electric lights.

Auburn, Me.—A 600 incandescent plant goes in Ara Cushman & Co.'s shoe factory.

Bridesburg, Pa.—The Mason Fruit Jar Company want somebody to equip them with an electric light plant.

Newark, N. J.—The Newark Electric Light and Power Company will erect a two-story machinery room and boiler house.

Honesdale, Pa.—The Honesdale Electric Light, Heat and Power Company has been incorporated. Capital stock, $15,000. President, Martin B. Allen.

The Government Printing Office, Washington, has, it is asserted, more electric lights in it than any other building in the country; and many of the lights are on perpetual circuit.

Chicago, Ill.—The Freeman Electric Light Company has been incorporated, by Mr. A. H. Chetlain and others, with a capital stock of $500,000.

New York City.—The new store of Stern Brothers, on Twenty-third street, is beautifully lighted by no fewer than 1800 Edison lamps, the plant being the largest of the kind in the country.

Brooklyn, N. Y.—The local *Eagle* is making war on the Citizens' and Municipal companies, now doing most of the electric light work in the city. It alleges bribery and corruption. Mr. Charles Cooper is the President of both corporations.

Cincinnati.—In the new Edison Central Station of the First Cincinnati Edison Electric Illuminating Co., the steam plant of which was erected by A. S. Fiske, agent for the Abendroth & Root Co., of New York City, Mr. Fiske has placed two 100-horse-power Root's new sectional safety boilers.

An Active Contractor.—Mr. Henry W. Pope, of 55 Broadway, has entered into a contract with the Cohoes Gas Light Company, of Cohoes, N. Y., for the construction of a 180-light arc plant, complete, of the Thomson-Houston system. He has also contracted to erect arc and incandescent plants at Carbondale, Pa., and Morristown, N. J.

APPLICATIONS OF POWER.

Bergen, Norway, gives a 30 years' concession for electric tramways.

The Daft Motor is receiving some very high commendations from a number of the firms that have been using it.

Orange, N, J., is to have an electric railway. Mr. H. W. Pope will equip it with engines, boilers, dynamos, motors, etc.

The Redstone Electric Motor Company has been incorporated in Chicago with a capital stock of $100,000, by E. Hinds, E. A. Irwin and T. B. Murphy.

Beer and Breezes.—Koster & Bial, the famous beer-gardeners and restaurateurs of Twenty-third street, think very highly of the motors that ran their fans for them this summer, and are liberal in their praise of the service given in that respect by the Edison and Sprague people.

Blackpool, England.—Mr. Holroyd Smith read a paper before the British Association at Birmingham last month, on his Blackpool electric tramway, now working so successfully. He stated that the cost of carrying 42,000 people weekly was $225, and he did not think that that figure could be equaled on any other line anywhere. He preferred a channel conductor to the use of accumulators. The paper was well received.

Satisfactory and Profitable.—In a letter to the New York *Times*, comparing motors with small steam engines, and speaking of their work, Mr. John Murray Mitchell says: "Again, the method of running is much simpler. There is no stoker required, as with steam engines. There is no attendant necessary where the power is used in the factory, the motor being absolutely self-regulating, in all cases doing its work when called upon, and being much easier, safer and cheaper to manage than the steam engines. A practical demonstration of the power as used for factory purposes can be seen in various places in New York City. There are also plants in operation now in Worcester and Boston, Mass., where they are giving entire satisfaction, and are very profitable."

A Modern Utility.—Mr. Thomas Whiteside Rae, C. E., remarks: "It is safe to say that the dynamo-electric machine is *per se* a more perfect apparatus to-day than the steam engine; also, that no objection has yet been urged against it, within its proper scope, for which a remedy has not at once been found. Electric propulsion and distribution of power have taken their places among modern utilities, and cannot be set aside by the physical and mechanical axioms of a period which, in this connection, is not less than paleozoic. The province of both is awaiting occupancy, and its extent cannot yet be even divined. That of the steam engine is not narrowed thereby, but, on the contrary, widely enlarged. The machine has probably reached its ultimate efficiency, but dynamo-electricity widens its field of usefulness beyond modern conception."

Daft Railways.—Mr. H. T. Buell told a *Sun* reporter last week that the experiments on the Ninth avenue road would be resumed with the heavy motor next month. He added: "The Daft motor has been used for over a year on the Baltimore & Hampden Street Railway, which is two miles in length, and is one of the most difficult roads in the country to operate. With horses and mules they were able to make only four miles an hour. With the electric motor eight are made. The cost of operating with horses and mules during eight months and twenty days was between $4,700 and $4,800. With the Daft motor during a like period 32,907 more passengers were carried, and the cost was only $3,160. The motors that do that work each weigh 5,000 pounds, draw nine tons, and cost $2,500. We are now fitting out two street railroads at Los Angeles, Cal., and expect to shortly build one in Pittsburgh. We will use on the Ninth avenue railroad a low-tension current of about 185 volts, which we find no difficuly in keeping on the track, and we recover from 60 to 65 per cent. of the power of the engine."

PERSONALS.

Mr. George Gould, who is the son of Mr. Jay Gould, and an officer of the Western Union Company, has married Miss Edith Kingdon, one of the most talented members of the famous Daly company. Mr. George Gould has certainly not injured his excellent reputation by this step.

Mr. C. C. Haskins read before the Fire Underwriters' Association of the Northwest, at its seventeenth anniversary, in Chicago, on Sept. 8 and 9, a paper on electric lighting and aërial wires. He came out "flat footed" for thorough inspection of plants and for universal burying of wires.

MISCELLANEOUS NOTES.

The Union Electric and Novelty Company, Denver, Col., has incorporated with a capital stock of $10,000. Mr. T. H. Patten is interested.

Revenged at Last!—The following pleasant little note reaches us from Southern friends, who, being among the builders of the New South, now enjoy some reward for their work: "You have very generously inflicted a copy of your journal upon us, semi-occasionally, for the past few years. If we hadn't been so poor, we would have had our revenge before. But we now remit post-office order, for which please afflict us some more."

Conduit Tests.—Mr. George Richardson writes us that the figures generally published, and by ourselves included, in regard to his conduit material on test, are incorrect. It was stated that the material broke under a pressure of 91 lbs. to the square inch, whereas the only piece he had tested on Aug. 19 by the Subway Commission stood a transverse pressure of 3,290 lbs. before breaking. Another piece tested by Dr. Ledoux on the same machine stood a pressure on Aug. 14 of 5,900 lbs. to the square inch.

The Electric Resistance of Woods.—Mr. Addenbrooke, of the United Telephone Company, has made a series of tests of the resistances of timber, the measurements being made by inserting terminals 2 in. apart in well-seasoned, sound pieces of the woods 3 in. by ⅛ in. by ⅜ in. in size. The pieces were kept for some time in a dry warm place to prevent surface conduction by moisture. The comparative resistances were, for mahogany, 48 megohms; for pine, 214 megohms; for rosewood, 291; lignum vitæ, 397; walnut, 478; and teak, 734 megohms respectively. These results were obtained with the electric current flowing in the direction of the grain; other measurements showing that when it flowed across the grain the resistance was from 50 to 100 per cent. greater.

An Improved Speed Gauge.—The Compagnie Générale d'Electricité, of Antwerp, has introduced a modification of the well-known Hedges or Ramsbottom speed gauge. The principal feature of novelty is that by means of an electric bell an alarm is given when the speed either rises or falls beyond certain limits. The arrangement is as follows: (1) When the speed falls, the depression of the central portion of the liquid decreases; contact is thus made with a metallic stem which projects into the centre of the cup; and (2) when the speed increases, contact is made by the upper surface of the liquid at the side of the cylinder, the upper part of which is insulated from the lower. There is also an ingenious arrangement for driving the containing vessel either from the top or the side of the shaft whose speed is to be measured.

Boiler Explosion.—President J. M. Allen, of the Hartford Steam Boiler Inspection and Insurance Company, a well-known expert on the subject of boiler explosion, states that "after twenty years' study of the subject among thousands of steam boilers, I am satisfied that there is little or no ground for mystery here. The principal causes of boiler explosions are poor material, fault in type, poor workmanship and careless management. There are new types of boilers devised every year, but the majority have but a short existence. The tendency to employ cheap engineers is no doubt a fruitful cause of disaster, and under careless management the best boiler may be ruined in a week or less. The desire for excessive pressures especially on boilers that have been some years in use, and that are not of sufficient capacity for the work reqnired, is another fruitful source of disaster. Steam users, in many cases, forget that with the enlargement of their works for increased production they should add correspondingly to their boiler power. They often try to provide for this increase of product by ordering their engineer to increase the pressure on the boilers. This is all wrong, and invites disaster."

SPARKS AND FLASHES.

A Baked Chestnut.—"They must be putting the telegraph wires underground at Posen," remarked Fangle. "What makes you think that?" asked Snippit. "Because the city of Posen has offered a large reward for the best essay pointing out new avenues of industry to Poles."—*Pittsburgh Chronicle.*

Trying to Get Her.—A telegraph operator in Milwaukee was one day trying to call up an office in a small town in the interior of the State, where the instrument was presided over by a woman. He was about giving up in despair when the operator in another small town a few miles distant from the first ticked out the query—"What in heaven's name do you want?" "I want Miss Brown at Burgville," replied the Milwaukee man. "I have been trying to get her for the last half hour." "That is nothing," came the reply; "there is a young fellow clerking in a dry-goods store there who has been trying to get her for the last three years, and he has not succeeded yet. Do not get discouraged."—*Chicago Rambler.*

STOCK QUOTATIONS.

Telegraph, telephone and electric light quotations on the New York Stock Exchange, Boston Exchange and elsewhere are as follows:

Telegraph.—Western Union, b 70⅛, a 70⅜.

Telephone.—Am. Bell, b 190, a 191; Erie, b 27¼, a 27½; New England, b 40½, a 40⅝.

Electric Light.—No new quotations.

BUSINESS NOTICES.

Magnetism in Watches.—

THE UNITED STATES ELECTRIC LIGHTING CO.

C. C. WARREN, 216 *La Salle Street*
Manager Western Department.

CHICAGO, Feb. 10, 1885.

Messrs. Giles, Bro. & Co.:

GENTLEMEN: I have now been carrying my watch encased in one of your Anti-Magnetic Shields for about a year, and it affords me pleasure to state to you that notwithstanding I have been very much about dynamo-electric machines during the time named, the anti-magnetic case seems to protect the watch perfectly from the magnetic influence of the machines. I have not made any special electrical tests, inasmuch as I regard the good running of the watch as all that is necessary. I am thoroughly convinced, from the effect upon my own watch, that the case is an excellent protection, and I may almost add an absolute proventive of magnetic influence from external sources to the delicate movements of a watch. My watch is a Howard watch, and during the period of two or three years previous to encasing it with your anti-magnetic case it had varied to a very great extent, and I had it demagnetized on two different occasions. I regard your case as a complete success, and if my indorsement of same is of any value, you are at liberty to use it.

Yours truly,

C. C. WARREN, *Manager Western Dept.,*
The U. S. Electric Lighting Co.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS DATED SEPT. 7, 1886.

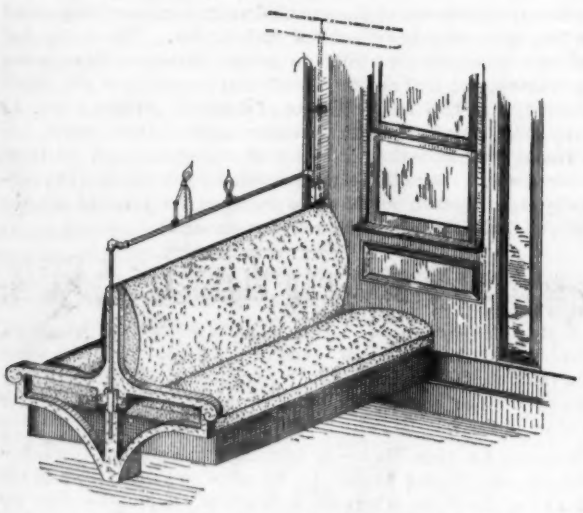
348,542. Electric Arc Lamp; L. G. Bronson, Chicago, Ill. In this lamp a shunt-magnet is placed between the positive and negative poles of the lamp. This magnet is made of a core and armature the same as the lift-magnet, the core being wound with wire small enough to offer such resistance to the current as to compel it to travel over and through the carbon-holder and carbons until the resistance in the arc is greater than the resistance in the shunt-coil. Then a part of the current is shunted off from the lift-magnet and it is demagnetized, allowing it to drop its armature, thereby causing the carbon to fall to the proper arc and do away with the surplus resistance in the arc, making the lift-magnet sufficiently strong to lift the holder and carbon to the proper arc. A clamp of peculiar construction is also shown.

348,572. Testing Station for Conduit Systems; James F. Munsie, Chicago, Ill., Assignor of five-twelfths to Horatio N. May, of same place. The object of the invention is to afford means whereby the wires contained therein are accessibly secured for accurate and expeditious testing and repairing purposes at convenient distances intermediate their initial and terminal points, likewise affording means for making auxiliary line-connections.

1) 348,578. Multiple Switch-Board; (2) 348,579. Multiple Switch-Board; T. J. Perrin, Brooklyn, N. Y., Assignor to Charles P. Huntington, Greenville, Miss. For full description see THE ELECTRICAL WORLD, Sept. 4, 1886.

348,603. Electric Railway Car Illumination; Edw. J. Wessels, Roselle, N. J. The object of the invention is to provide a simple device whereby the lamp may be supported near the head of any person sitting in the seat, and may in the day-time be removed to a receiving closet on the side of the car with very little trouble. The lamp is supported upon a rod projecting from a universal joint, and when not required the rod is raised and the lamp fits into a box on the side panels of the car. The accompanying illustration shows the invention clearly.

348,606. Electric Air-Pump System; A. B. Worth, Greenport, N. Y. The invention relates to an electric air-pump system involving the application of electricity to the operation of the valves, and improvements upon the devices and appara-



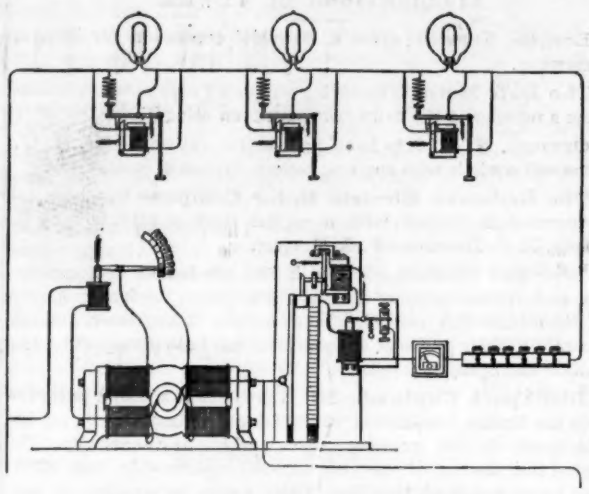
348,603. RAILWAY CAR ILLUMINATION.

tus described in United States patents Nos. 337,803 and 337,804, both of March 9, 1886. The object of the invention is to provide means for operating two or more air pumps in series; to operate all valves by the aid of electricity in a superior manner, and to provide in general a complete system for automatically operating vacuum air pumps. The object of placing two pumps in series with but one receiver is to accomplish rapidity of exhaustion, each pump being itself as large as it is practicable to build them.

348,625. Manufacture of Secondary Batteries or Accumulators; Stephan Farbaky and Stefan Schenek, Schemnitz, Austria-Hungary. This is an improvement upon their battery described in THE ELECTRICAL WORLD, Aug. 7, 1886.

348,636. Electro-Magnetic Brake; Harvey S. Park, Henderson, Ky. The inventor employs a rack-bar, of steel or other magnetic metal, arranged within the field of an electro-magnet and mechanically connected with the brake-lever. With the face of this rack-bar a steel pawl actuated by the car-wheel axle is made to engage whenever the rack-bar is magnetized by a current passing through its surrounding or neighboring magnet. When this magnet thus forms a part of the closed electric circuit, the rack-bar will be fed longitudinally and the brakes applied. A locking-pawl is arranged to engage with teeth on the rack-bar, and thus retain it to any position to which it has been forced. The locking-pawl is also governed by an electro-magnet, and may be operated to release the brakes by closing the circuit through the magnet.

(1) 348,646. Safety Strip for Electric Circuits; (2) 348,647. Holder for Incandescent Lamps; (3) 348,648. Ampere-Meter; (4) 348,649. Electric Lighting System; Edw. Weston, Newark, N. J., Assignor to the United States Electric Lighting Company, New York, N. Y. (1) The strip is inserted between two spring-terminals, that are forced apart to a sufficient extent by the insertion of the strip to maintain a constant spring-pressure. In order to prevent bending or yielding of the strip, it is placed in a suitable holder. (2) The object of the invention is to provide a means by which an incandescent lamp of any construction may be attached to a holder. To this end the inventor supplies a "coupler" or "adapter." These couplers or adapters are made so as to receive the base of a given lamp and to fit into a given holder or socket, and to complete the circuit-connections from the lamp to the holder. (3) For full description of this ampère-meter see THE ELECTRICAL WORLD of March 27, 1886. (4) The invention, as illustrated, consists of the following system: From a dynamo-electric machine provided with a current regulator a circuit is run, which is divided up into a number of branches or cross circuits, in each of which are two or more incandescent lamps in series. Each lamp is provided with a cut-out, or a device which operates to close a short circuit around the lamp when for any reason the latter is extinguished. In each of the cross-circuits near the generator is a current indicator that shows any change in the current flowing through the circuit in which it is included, or any change of resistance therein, assuming a regulator to be used that tends to maintain a constant current. There is also in each branch circuit a variable resistance—such as a plug rheostat—by which the resistance of the circuit containing it may be raised when the indicator shows too much current flowing in it, or conversely. There is, further, an electro-magnet in each branch circuit that acts upon an armature pivoted to vibrate between two adjustable contact-points. When the armature comes into contact with either of these points, it closes a circuit through a second magnet, that trips or releases a retarded or gradually-operating circuit-



348,649. ELECTRIC LIGHTING SYSTEM.

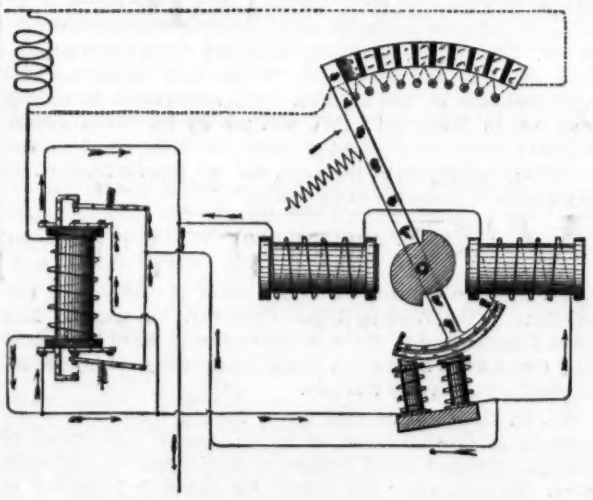
breaker in the branch circuit, the purpose of this being to gradually interrupt the branch circuit when the current becomes either abnormally high or abnormally low, the gradual interruption being effected by inserting a resistance that increases up to a certain point before the actual break is made. By this means the regulator on the generator has time to act and compensate for the variation of resistance which the interruption of a branch circuit produces, so that the remaining branches are not sensibly affected and the current is not abnormally or injuriously increased.

348,707. Automatic Fire-Alarm System; A. D. Wheeler, Boston, Mass., Assignor to the American Automatic Fire-Alarm Association, Portland, Me. The invention is an improvement upon that described in the patent to James A. Tilden, No. 301,645, dated July 8, 1884; and it consists in means whereby the circuit may be tested by the watchman without sounding the alarm unless a wire should be broken or the circuit interrupted, in which event the alarm is sounded.

348,708. Electric Connection for Chandeliers; J. P. Willets, Jersey City, N. J., and E. R. Crolius, New York, N. Y. The invention relates to the construction of an apparatus designed to maintain a continuous electric connection between the main line wires and the lamps carried by a chandelier that is suspended by means of a ball-and-socket joint. It consists of two metallic rings insulated the one from the other but connected with the main-line wires, one of the rings being connected with the main-line wire leading to, while the other is connected to the wire leading from the chandelier, each ring being in yielding electric communication with wires carried by the swinging portion of the chandelier, the insulated rings being held and supported by the stationary coupling or by the gas-supply pipe; the invention further consists in the arrangement of an auxiliary bushing of insulated material whereby the chandelier is insulated from the system of gas-supply pipes.

348,771. Magnetic Ore Separator; C. Q. Payne, Stamford, Conn. The separator consists, essentially, of a series of hollow electro-magnets placed one within the other, and of a cover which forms a practically continuous magnetic surface.

348,792. Electric Tramway System; M. Holroyd Smith, Halifax, County of York, Eng. The invention consists in improved forms of electrical conductors employed in electric tram



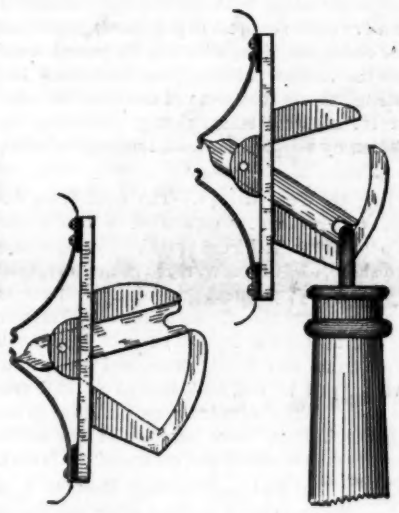
348,876. CURRENT REGULATOR.

way systems, and in the means by which they are mounted, insulated and supported from the surrounding parts. One of the principal forms is described in THE ELECTRICAL WORLD, Feb. 27, 1886.

348,799. Electric Arc Light; Frank Thone, Fort Wayne, Ind. The invention relates to a "differential" arc lamp, and describes novel feeding and regulating devices.

(1) 348,875. Switch Socket for Incandescent Lamps; (2) 348,876. Electric Current Regulators; Merle J. Wightman, Hartford, Conn., Assignor to the Schuyler Electric Light Co. (1) The object of the invention is to furnish a switch adapted for employment upon circuits in which the incandescent lamps are placed in series with arc lamps or with other incandescent lamps or other electrical devices through which the current requires to be maintained in case an incandescent lamp is removed from its socket. The invention consists in a novel socket-switch so constructed that in the act of removing the lamp the circuit shall be established between the two outside conductors supplying current to the lamp before the lamp terminals are withdrawn from electric connection with the conductors. (2) The invention consists in the combination, with the operating-lever for the adjusting devices, of certain combinations of motor-magnet and a clamping or brake magnet thrown into and out of action as shown in the illustration. The cut shows the lever by means of which the proper adjustments of the current-regulating devices proper are effected. This lever is furnished with an armature, which is placed within the attractive influence of motor-magnets, so that when these magnets are energized the lever is turned in the direction of the arrow. The spring moves the lever in the opposite direction when the magnets cease to operate upon the armature. Acting also upon the operating lever is another electro-magnet, which is the clamp-magnet and which serves to hold the lever positively in any one of its adjusted positions. The clamp-magnet is thrown into and out of action by suitable circuit-controlling devices, which come into play when the lever is to be moved in one or the other position, and which hold the magnet out of action until the proper position of the lever is attained. At this time the clamp-magnet comes into action to clamp the lever, and the motor magnets, if the movement has been effected by their agency, are at such time thrown out of action. The clamping is effected by means of an armature, carried on the lever, and having a slight movement which will permit it to be drawn toward the pole of the clamp-magnet, and held firmly against the same when it is desired to clamp the lever. The magnet is mounted on pins, as shown, and is provided with springs which tend to draw the armature away from the poles of the magnet. When the magnet acts, the armature is held against the poles, and the lever is prevented from turning. When the magnet ceases to act, the springs withdraw the armature, and the operating-lever can then be turned, either by the agency of the spring or by the motor-magnets. The operation of the magnets is controlled by an auxiliary magnet, and its attachments placed in the main circuit

348,880. Insulating Conduit; Wm. W. Averell, Washington, D. C. The invention relates to improvements in insulating conduits for the purpose of transmitting electrical energy to a motor by which a public conveyance is propelled, or for underground wires, or both. The invention contemplates a two-fold purpose, viz., the mechanical anchoring of the conducting-rail in such manner that it shall not be displaced, and



348,936. TELEPHONE SWITCH.

the insulation of the same. Both of these objects are attained by laying the rails in soft cement, which is then allowed to set, whereby it is held in place with great strength and firmness, and at the same time fully insulated, the tread of the rail only being exposed.

348,883. Armature for Dynamo-Electric Machines; Aug. Bossard, New York, N. Y. The principal object of the invention is to promote and effect a more rapid and complete magnetic discharge of the wire core in the Gramme armature than has heretofore been attained. The invention consists, primarily, in subdividing the wire core into separate and independent sections corresponding to the spools of the armature, each section being composed of a suitable number of short links or pieces of wire inclosed in a sheet-iron box or trough, around which is wound the insulated wire composing the spool, by which means an independent discharge for each spool is obtained.

348,896. Mechanical Telephone; Wm. H. Eastman, Concord, N. H., Assignor by mesne assignments to the Popular Telephone Co., same place. The object of the invention is to avoid the ring and excessive vibration in the centre of the diaphragm. At the back of the diaphragm is a wire screen touching the diaphragm only at the centre. Behind the wire screen and the back board of the telephone a packing of "excelsior" or similar material is placed.

348,901. Galvanic Battery; Wm. C. Goldner, Boston, Mass., Assignor to the Chemical Electric Light & Power Co., Portland, Me. For full description see article, "An Improved Cell for Domestic Electric Lighting," THE ELECTRICAL WORLD, May 1, 1886.

348,927. Electric Arc Lamp; Gustav Pfannkuche, Hartford, Conn., Assignor to the Schuyler Electric Light Company, same place. The invention comprises improvements in that class of arc lamps in which the carbon rods are normally in point-to-point contact preparatory to the drawing of the arc, and in which the arc is established by means of an electro-magnet in the arc branch, while the feeding of the carbon is effected by a step-by-step action through the agency of a high-resistance electro-magnet placed in a shunt branch, which joins the opposite poles of the lamp.

348,936. Telephone Switch; Wm. C. Turnbull, Baltimore, Md. The accompanying illustrations show the invention fully. The act of removing and replacing the telephone in the notched lever cuts the telephone in and out of circuit.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patent issued since 1866—can be had from this office for 25 cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, New York.